

Imaging Choices in the Management of Colorectal Cancer Part 1

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Imaging Choices in the Management of Colorectal Ca

Review staging Colorectal Ca

Local staging

Lung and liver lesions

PART 2: PET/CT Dr. Pete Tonseth



No time

Colon Ca

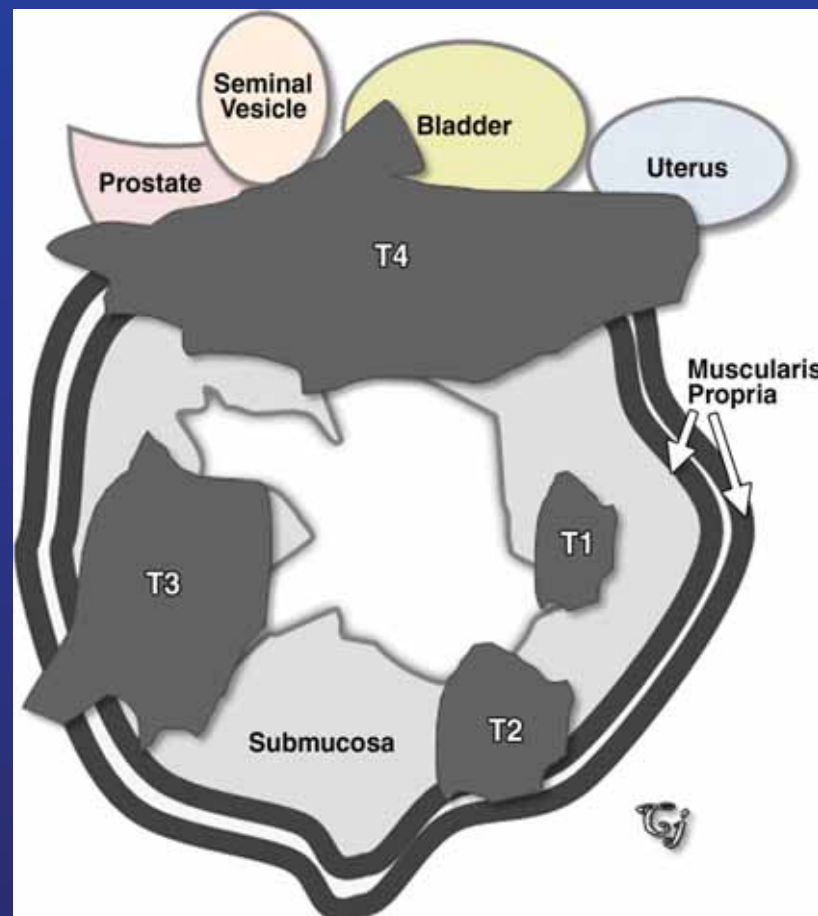
Details local Rectal staging

New Imaging Techniques (MR)

Tumor regression post Ch/RT



Local Staging Rectal Cancer



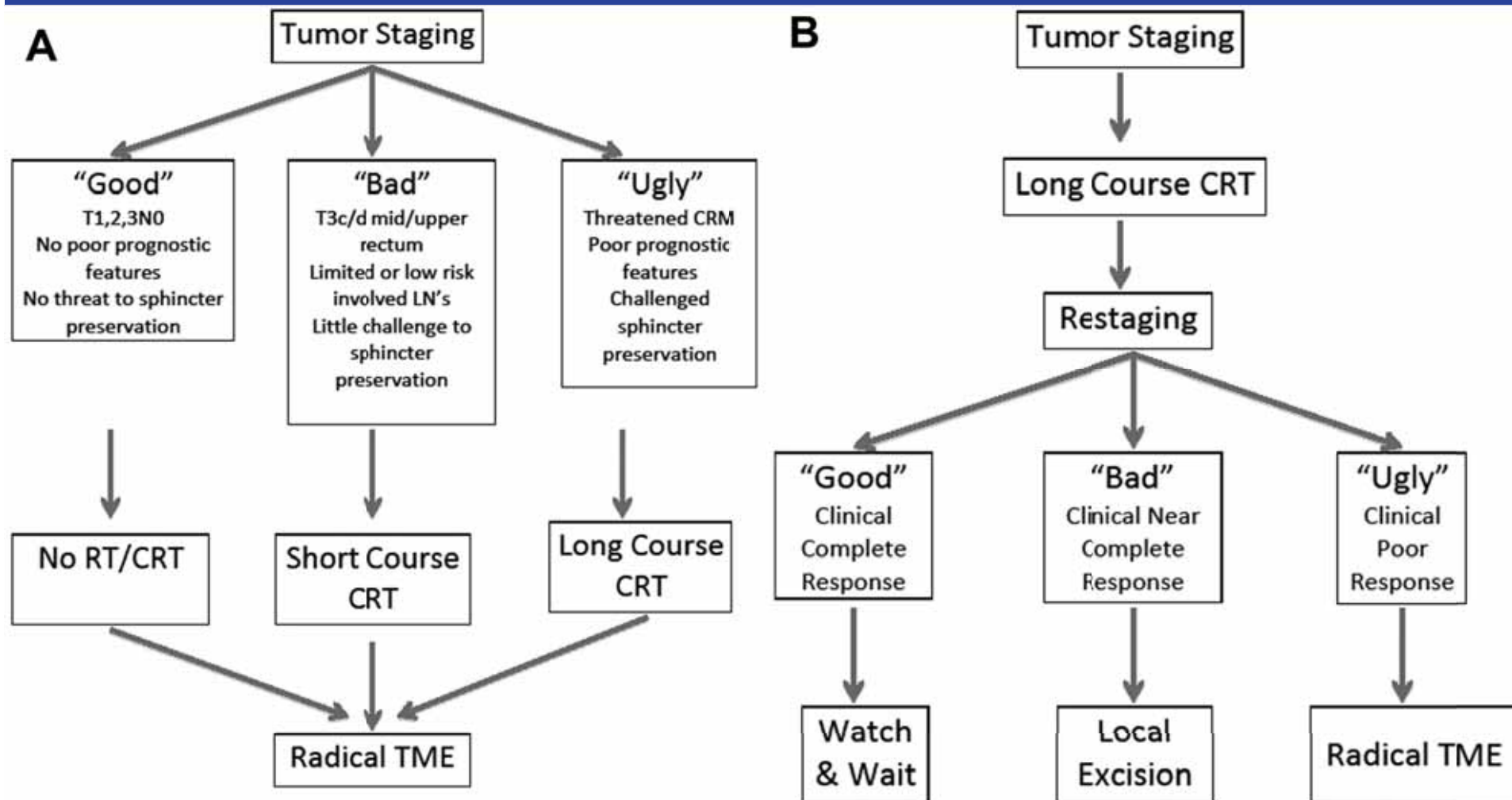
Kaur H et al. Radiographics 2012;32:389-409

RadioGraphics

Rectal Ca Local Staging

Accuracy DRE T staging 58-88%

EUS Staging information changed the surgeon's original treatment plan based on CT in 31% of patients



BCCA Rectal Cancer Group Guidelines

Clinical Stage 1 (T1, T2, N0, M0)

- Segmental resection. No preop radiation
- Local excision if favorable T1 lesion

Clinical Stage 2 (T3, T4, N0, M0)

- Preop short course radiation
- Segmental resection. Local excision contraindicated

Clinical Stage 3 (any T, N1, N2, N3, M0)

- Managed as for stage 2
- Preop radical preoperative chemoradiation may be indicated

Clinical Stage 4 (any T, any N, M1)

- Excision of primary tumor
- Chemoradiation
- Resection of metastatic lesion
- Fulguration/laser/ endoluminal radiation



BC Cancer Agency
CARE & RESEARCH

BCCA Rectal Cancer Group Cancer Management Guidelines

- Complete colonoscopy
- Tumour height
- **Accurate preoperative staging**
- Preoperative CEA
- PET scan not recommended
- Core biopsy in patients with unresectable disease

Accurate preoperative staging

- Location (height)
- TNM staging
- Free resection Margin TME

Tumor Location

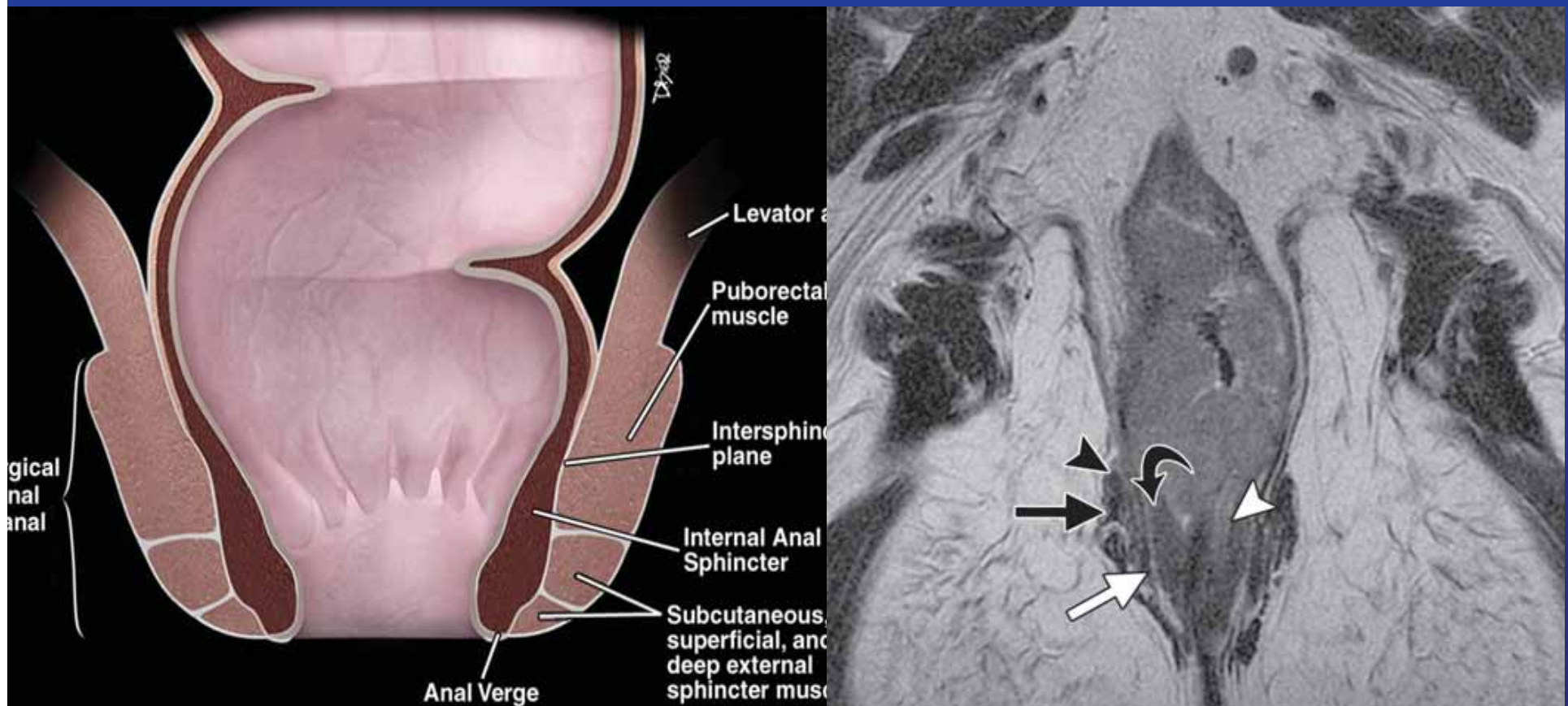
- Surgical planning
- Determine pre-op management
- Most distal location of the tumour is used to define tumour location

Tumour Height Measurement

Decreasing order of reliability???

- 
1. Rigid sigmoidoscopy
 2. Flexible sigmoidoscopy/colonoscopy
 3. Endorectal ultrasound (can overestimate)
 4. DRE (low lying tumours)
 5. CT or MRI

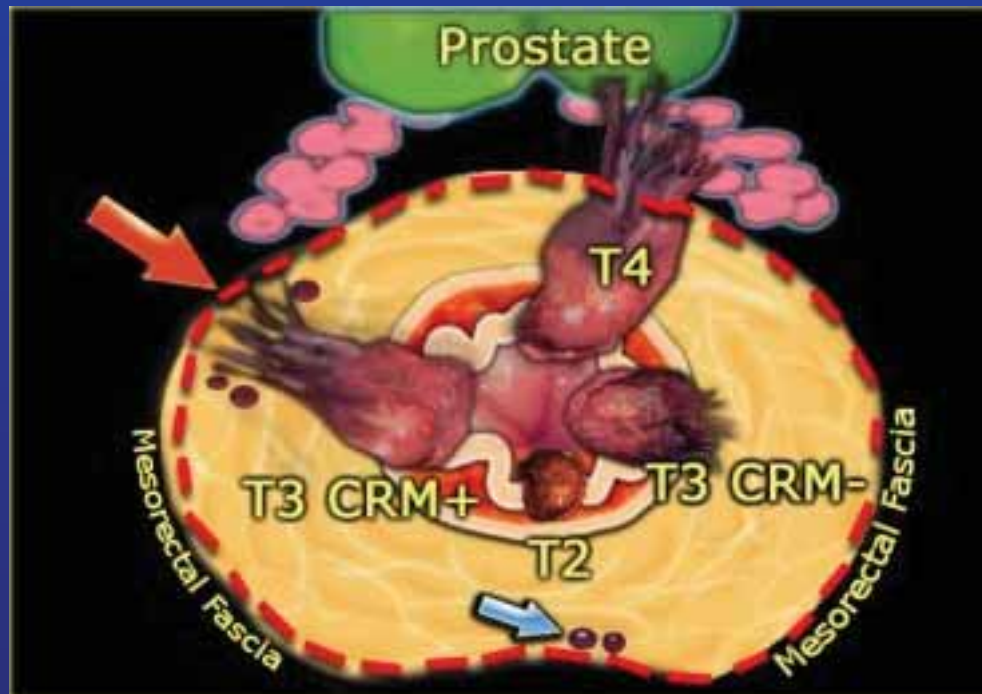
Relationship to anal sphincter



*Kaur H et al. Radiographics
2012;32:389-409*

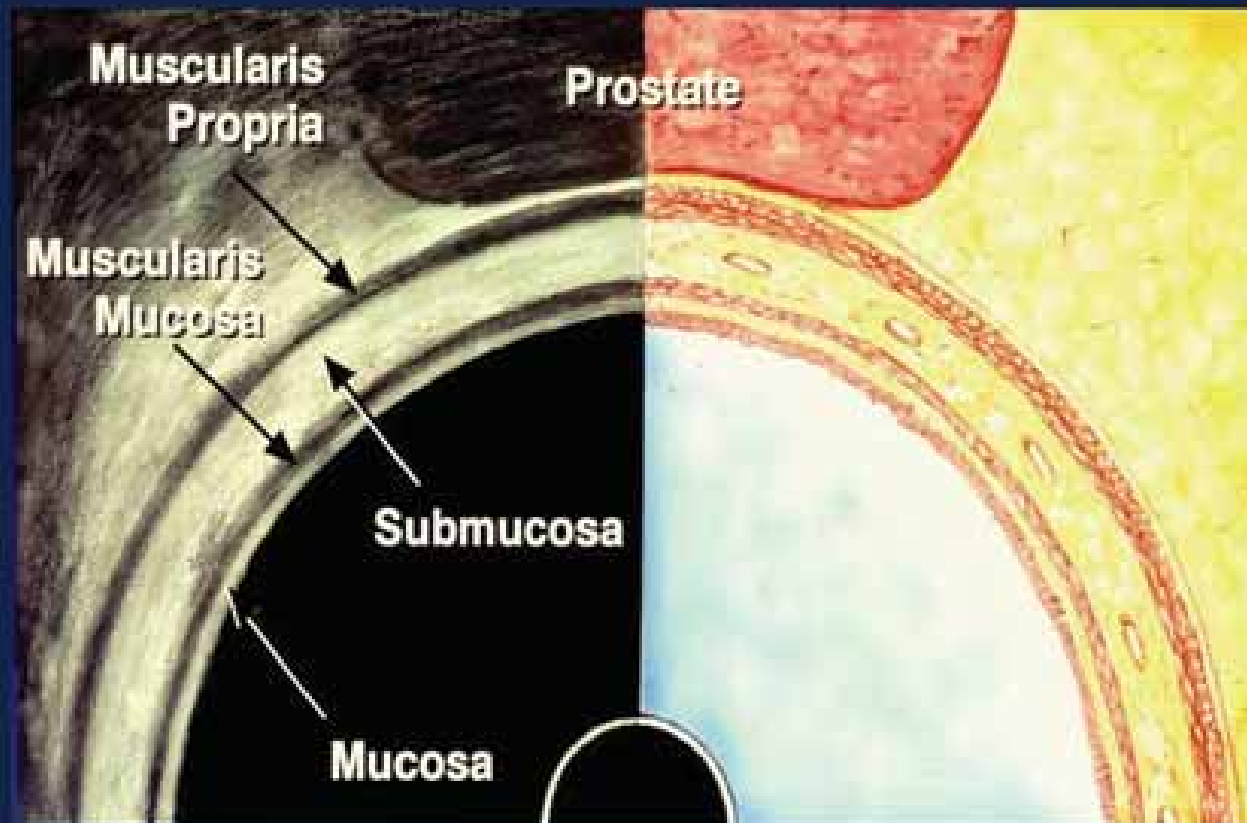
RadioGraphics

T STAGE

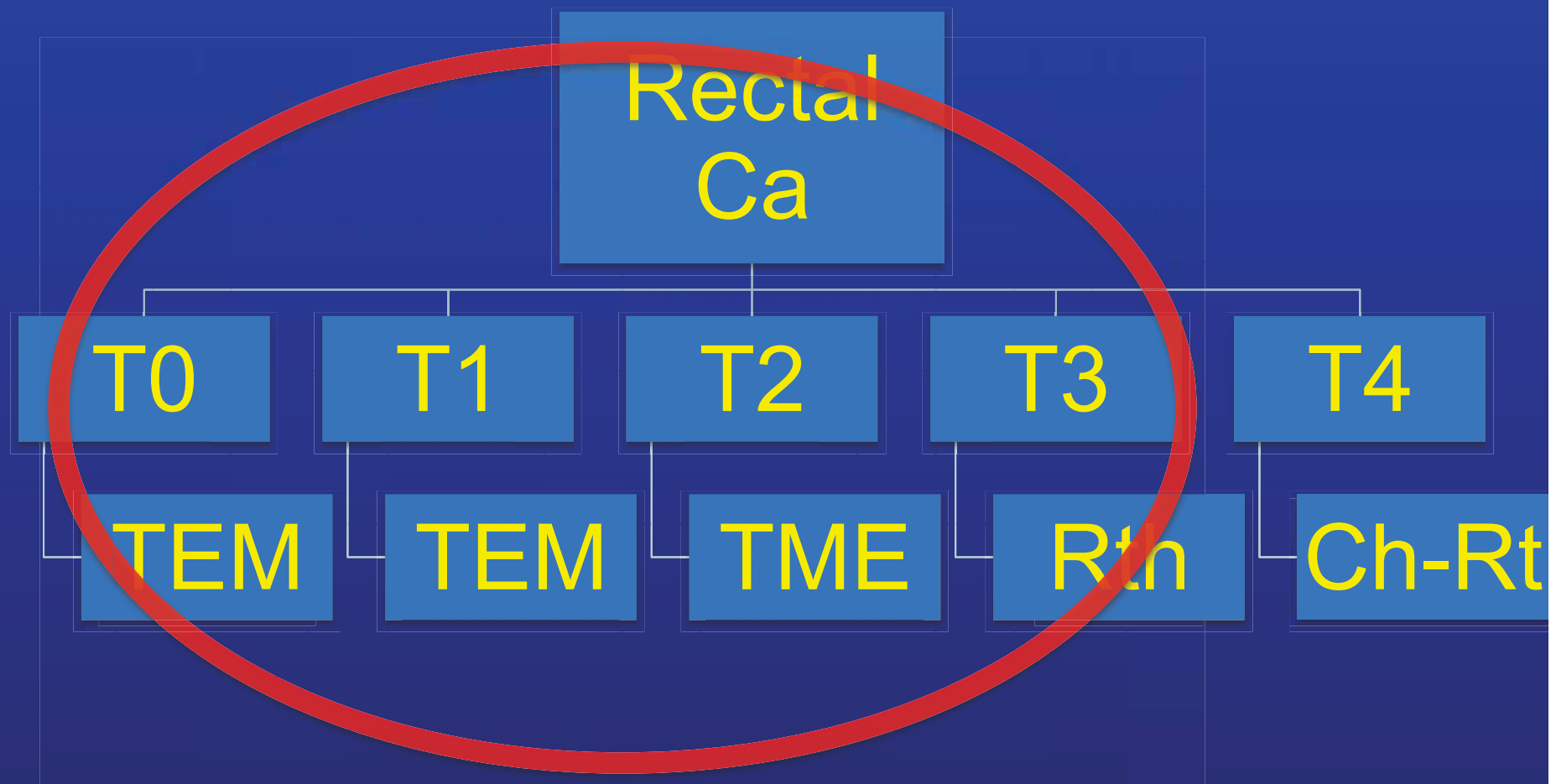


Best imaging modality determined by T Stage

Endorectal Ultrasound



<http://www.medscape.org/viewarticle/>



ERUS

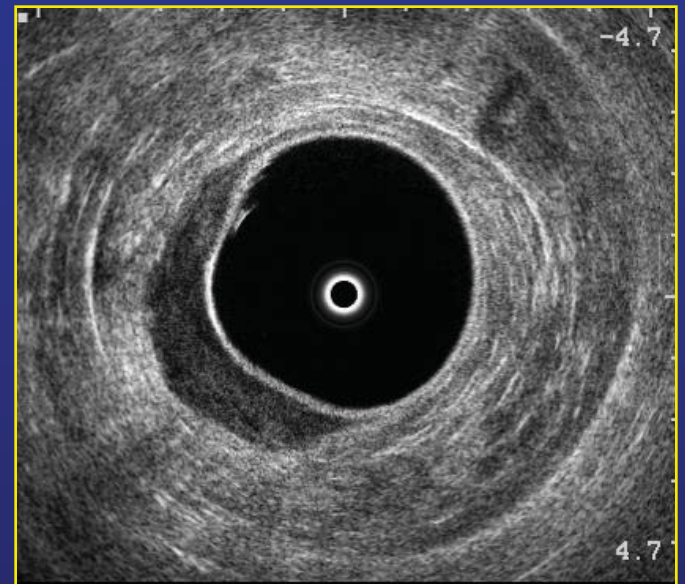
Rectal Cancer

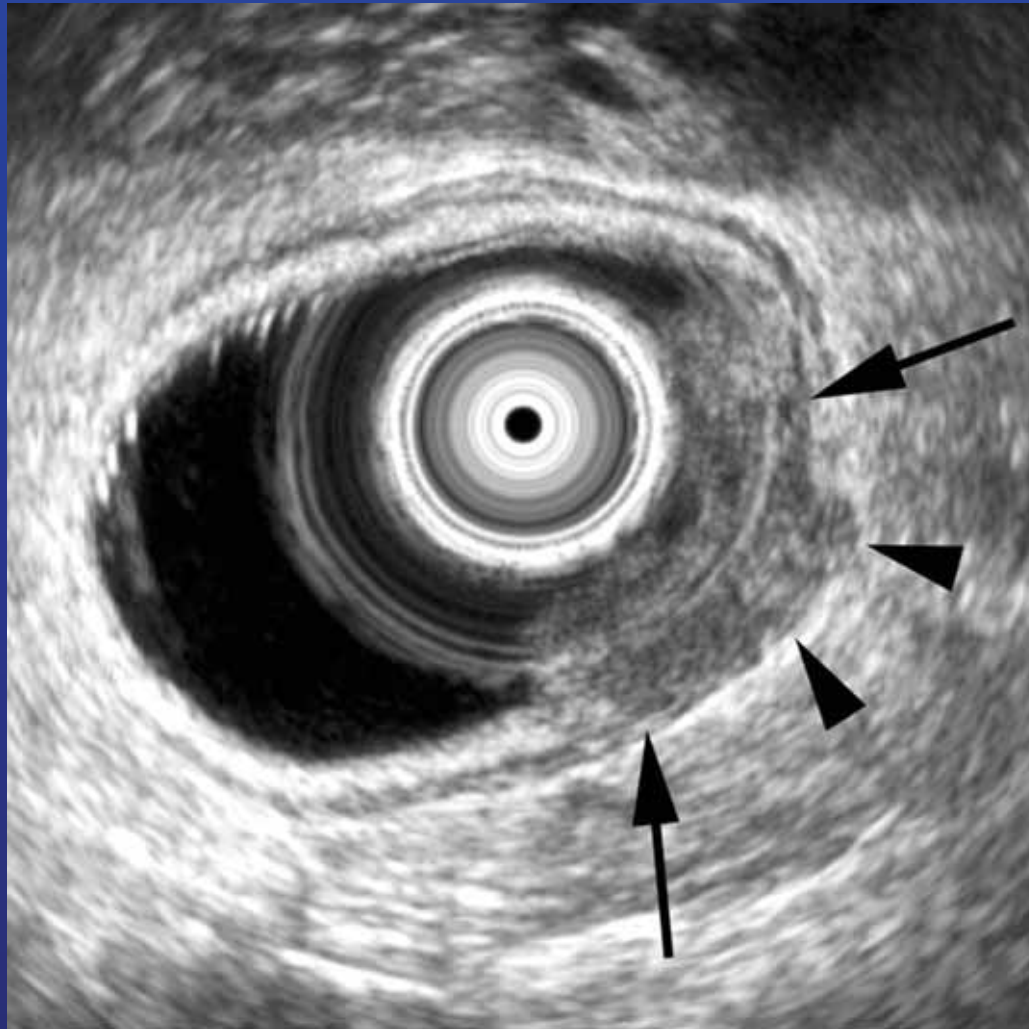
Advantage:

High Spatial Resolution

Differentiate T0-T1-T2-T3

In office





T3 rectal cancer

ERUS

Disadvantage:

Availability/Expertise

High/low/obstructing tumors

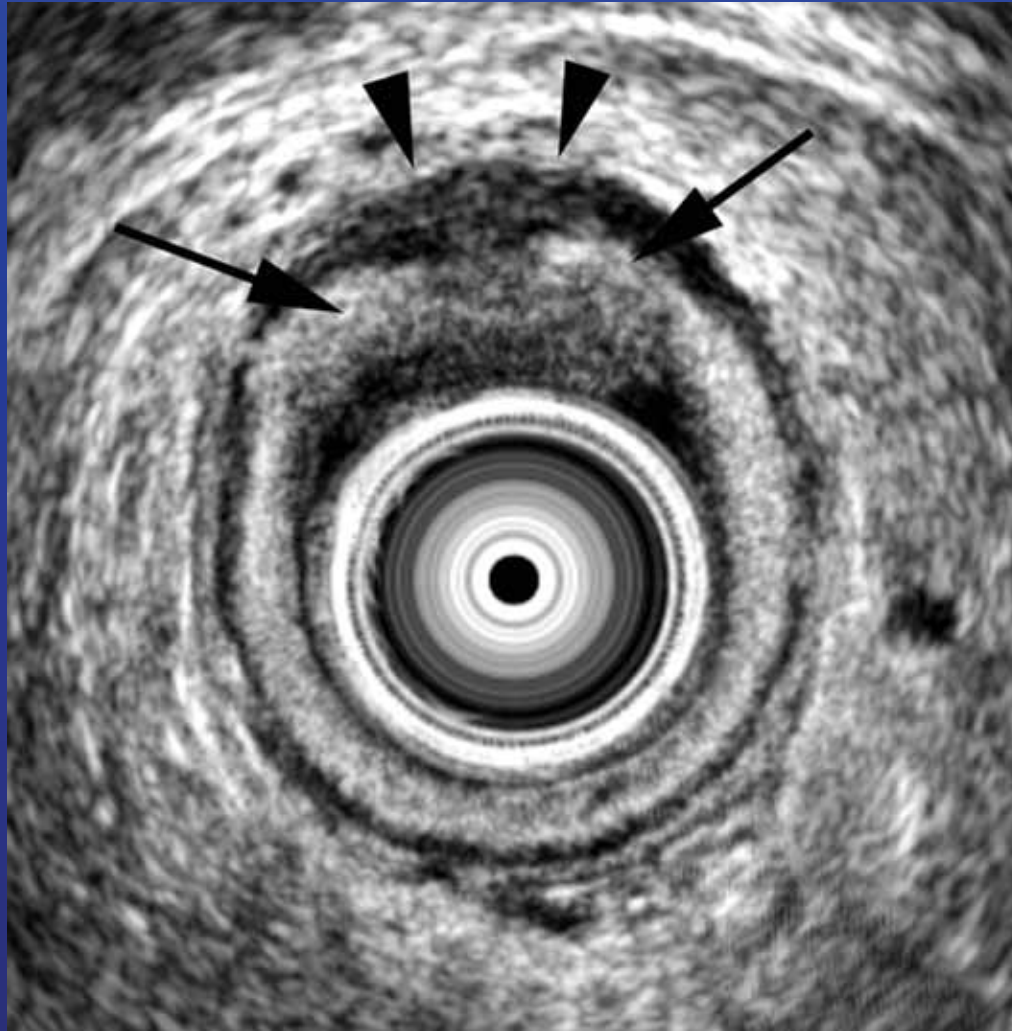
Discomfort

Cannot see MRF

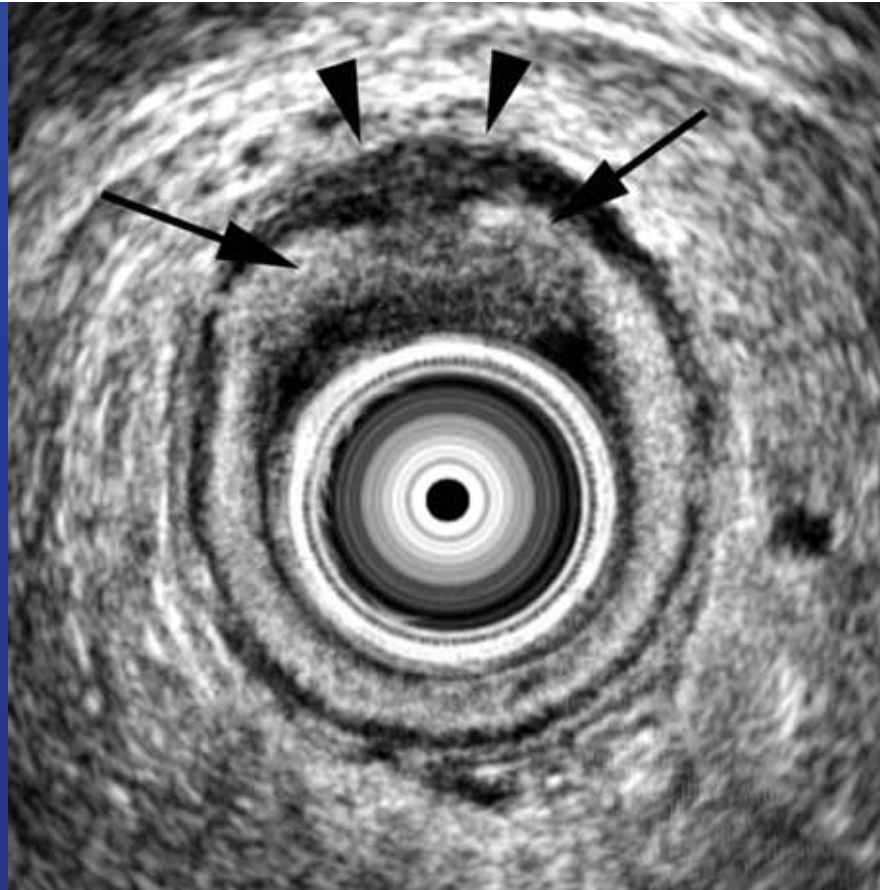
May overestimate distance

Overstaging: 20% T3-T4 actually T2

Sauer R, N Engl J Med. 2004;351:1731-1740.



T Stage?



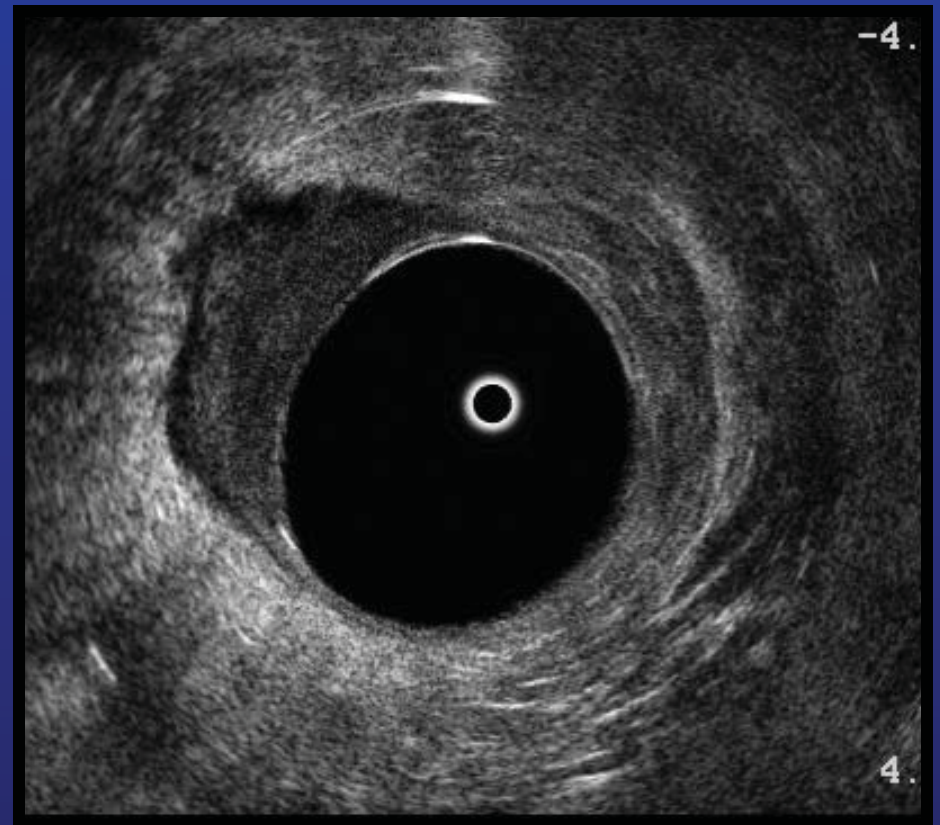
T2

Transverse ERUS invading muscularis propria
Perirectal tissue is clear

T = Primary Tumor

uT3:

- Tumor penetrates the entire thickness of the bowel wall and invades the perirectal tissues



ERUS T0-T1

Meta analysis

Sens

Spec

Tis

Puli (*Dig Dis Sci 10*)

97

96

T1

Bipat (*Radiology 04*)

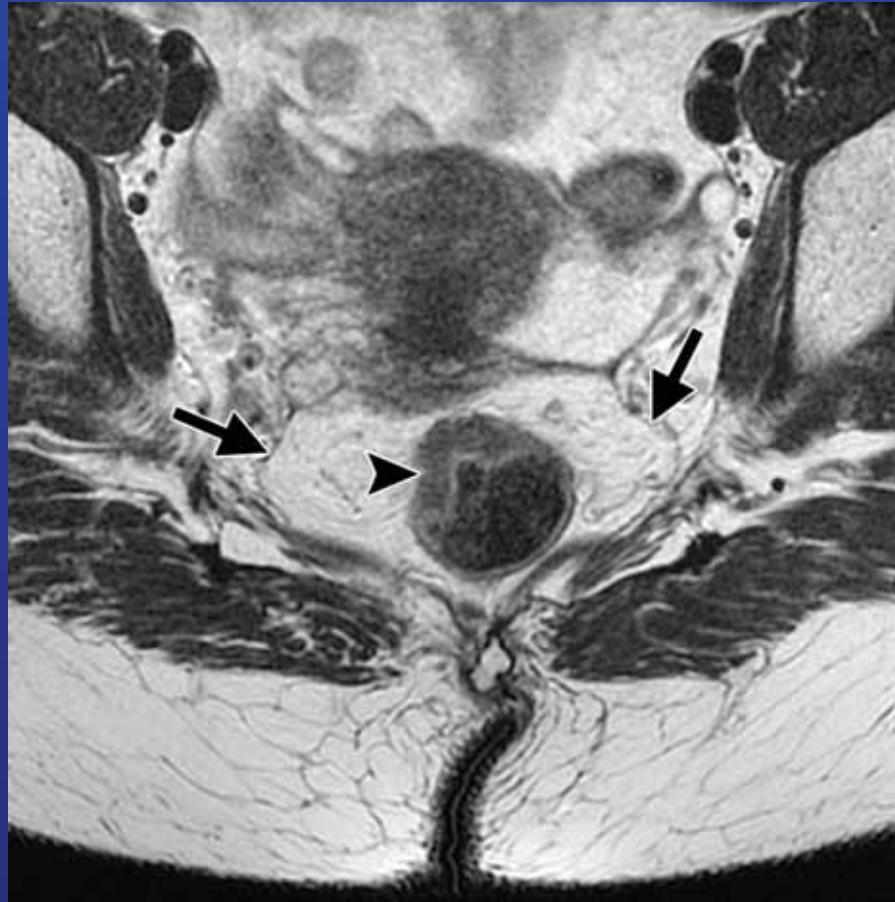
94

86

Puli (*Ann S Onc 09*)

88

98



MRI

Rectal
Ca

T0

T1

T2

T3

T4

TEM

TEM

TME

Rth

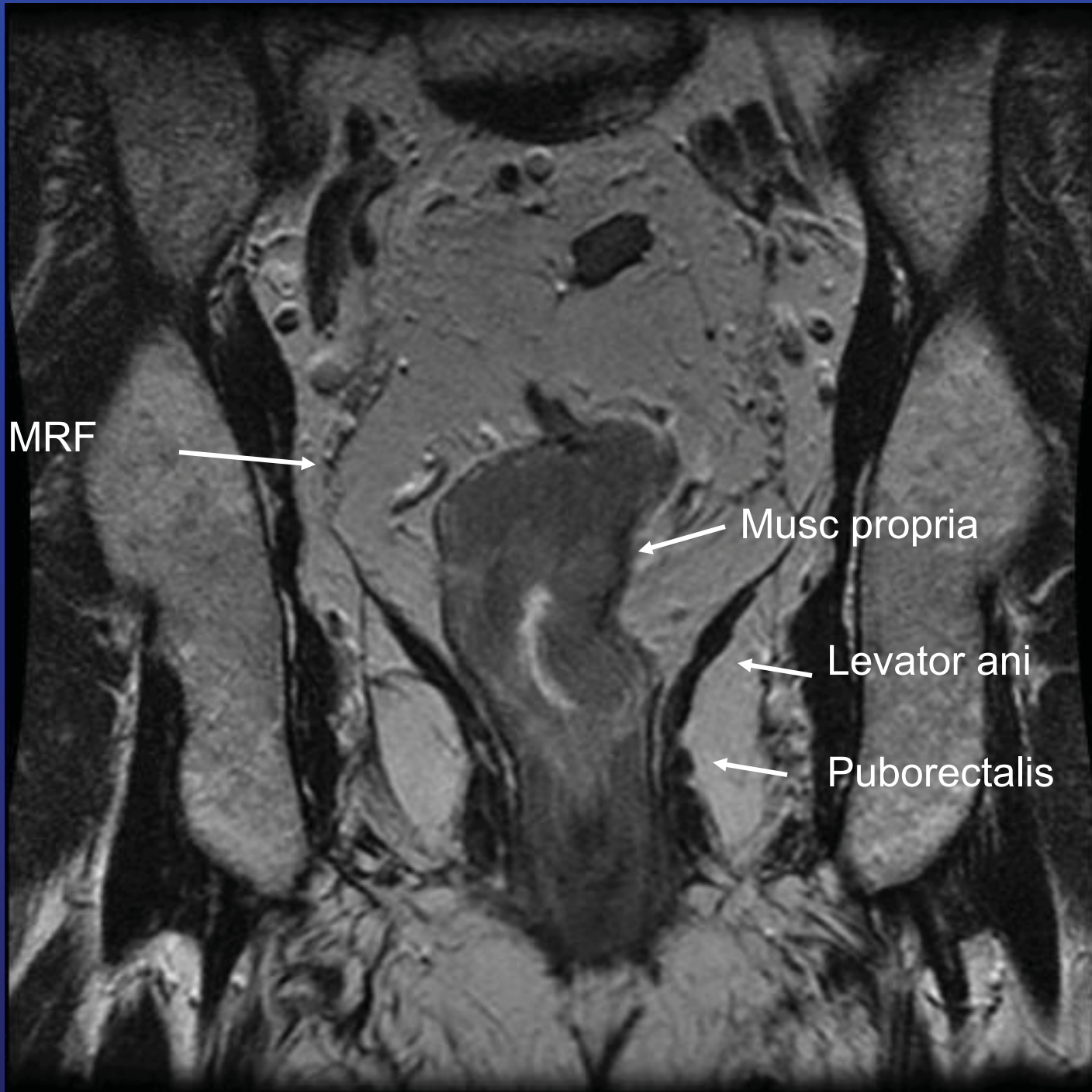
Ch-Rt

MRI

MRI advantage:

- High Spatial Resolution
- More available ERUS?
- Best Method to see MRF

Sauer R, N Engl J Med. 2004;351:1731-1740.



MRF

Musc propria

Levator ani

Puborectalis

MRI

advantage:

- Reliable and reproducible technique with high specificity (92%) for:
 - relationship to the MRF
 - Depth tumor invasion outside muscularis propria

MRI

Disadvantage:

- Availability
- Claustrophobia etc
- No staging outside pelvis

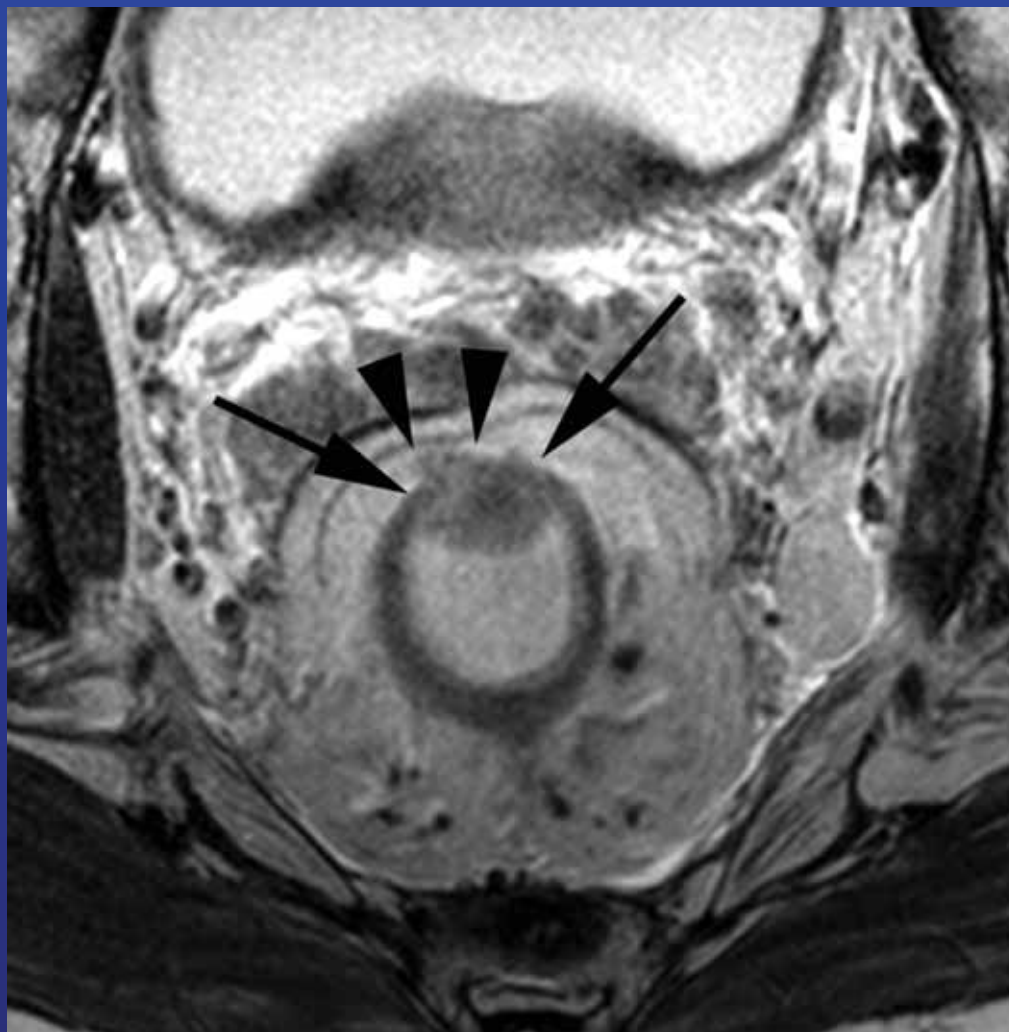
MRI

Disadvantage:

- Expertise
- Interobserver variability
- Need High Resolution Images

- Limitations borderline T2-T3
- Overstaging T2 29-40%

Sauer R, N Engl J Med. 2004;351:1731-1740.

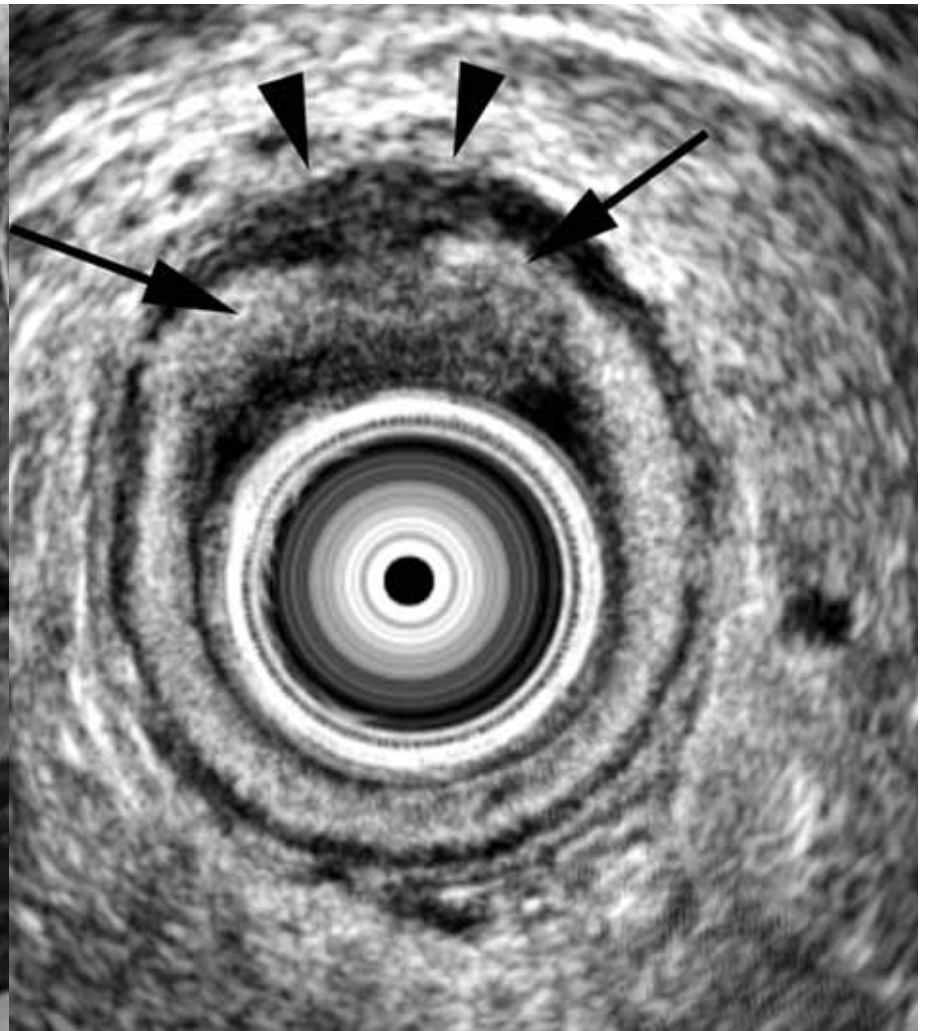


T?

Chun H et al. AJR 2006;187:1557-1562



T3?



T2

Chun H et al. AJR 2006;187:1557-1562



ERUS/MRI

T2/T3	Sens	Spec
MRI	94/82%	70/75%
ERUS	94/90%	85/75%

Bipat et al. Radiology 2004

Rectal
Ca

T0

T1

T2

T3

T4

TEM

TEM

TME

Rth

Ch-Rth

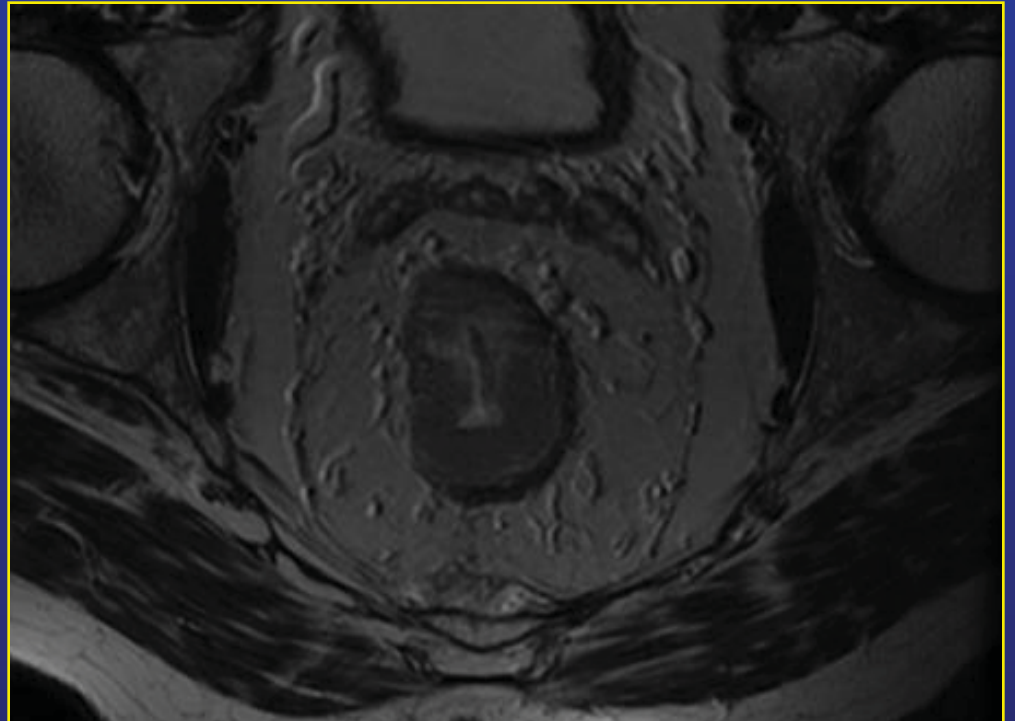
MRI=CT

CT

advantage:

- Fast
- Available
- Staging entire chest/abd/pelvis

Mesorectal Fascia CT



CT Accuracy



Parameter	Stage $\leq$ T2 (pT1, $n = 3$; pT2, $n = 10$)		Stage T3 (pT3, $n = 25$)		Stage T4 (pT4, $n = 3$)	
	Transverse Images Alone	Transverse and MPR Images Combined	Transverse Images Alone	Transverse and MPR Images Combined	Transverse Images Alone	Transverse and MPR Images Combined
Accuracy	90	93	85	90	80	98
Sensitivity	82	92	76	88	100	100
Specificity	93	93	100	94	79	97
Positive predictive value	82	86	100	96	27	75
Negative predictive value	93	96	73	83	100	76

Filippone A et al. Radiology 2004;231:83-90

Radiology

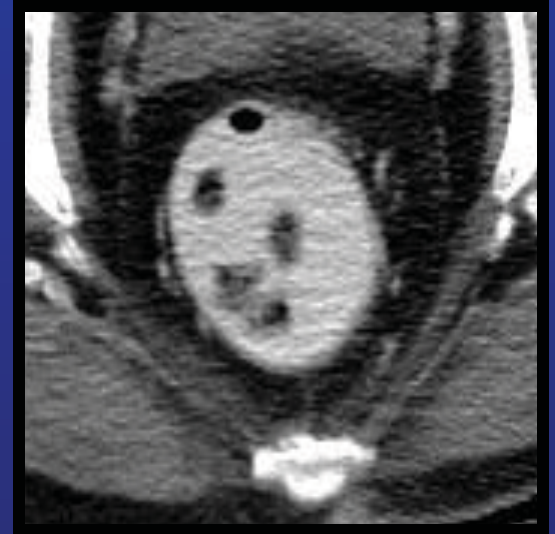
CT disadvantage:

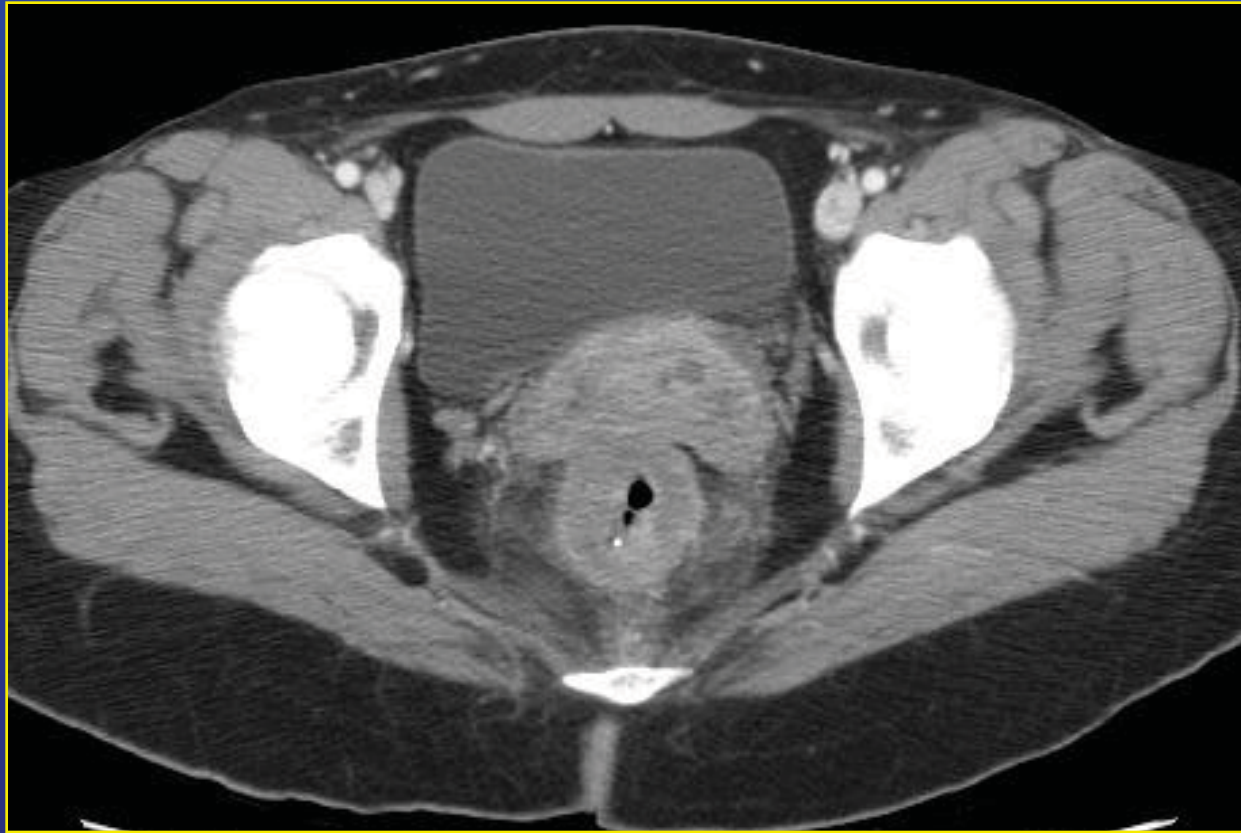
- Less detailed spatial and contrast resolution

Accuracy

advanced T3-T4 79% to 94%

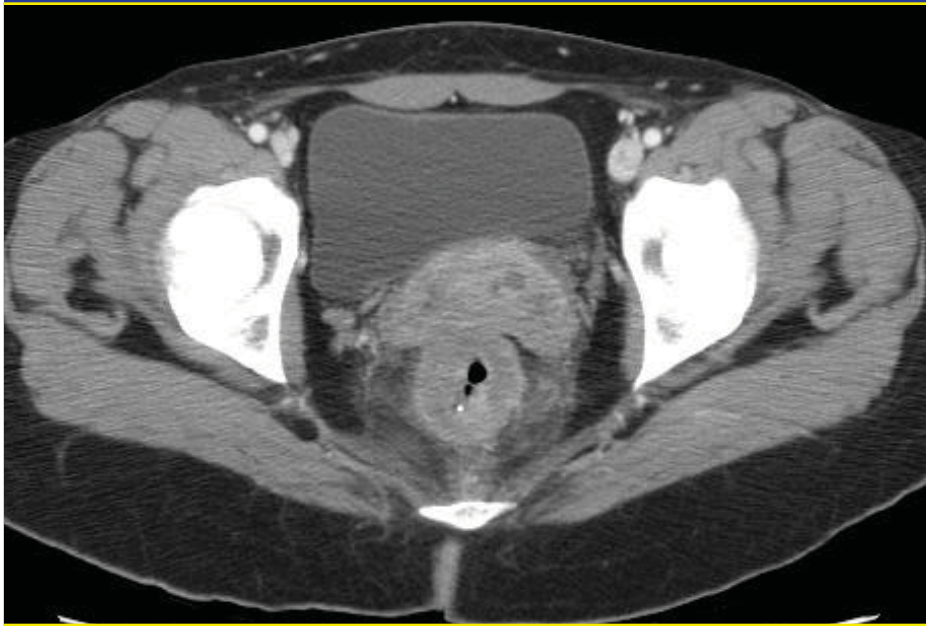
All stages 52% to 74%



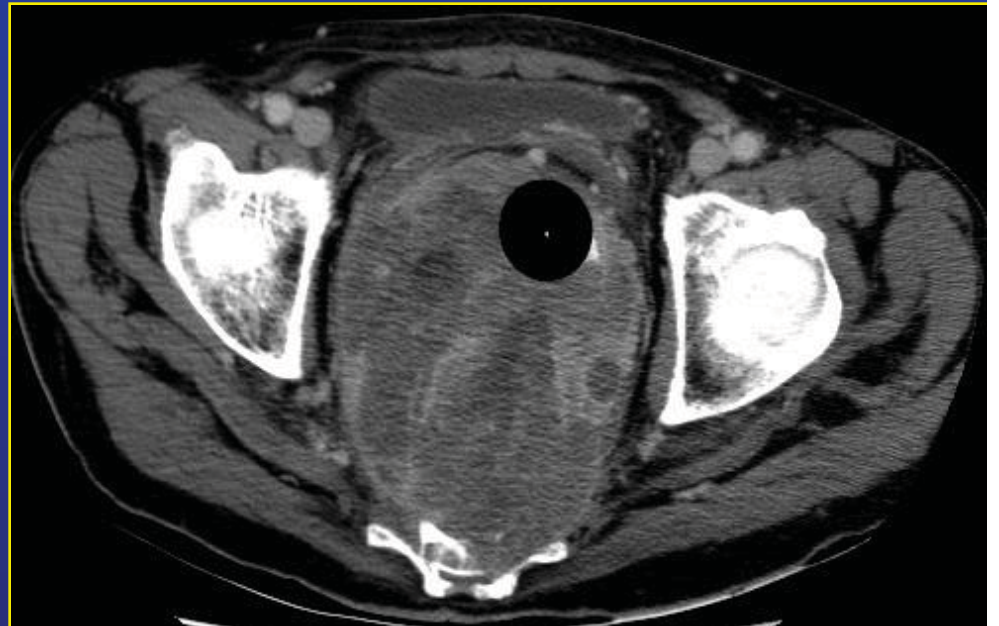


T Stage?

T4 Lesions



**Loss of fat plane between tumor
and lower uterine segment**



Sacral invasion

Nodes

N = Regional Lymph Nodes

NX

Regional lymph nodes cannot be assessed

N0

No regional lymph node metastasis

N1

Metastasis in 1 to 3 regional lymph nodes

N2

Metastasis in 4 or more regional lymph nodes

N3

Metastasis in a lymph node along the course of a named vascular trunk

N = Regional Lymph Nodes

Distribution depends on level of tumor:

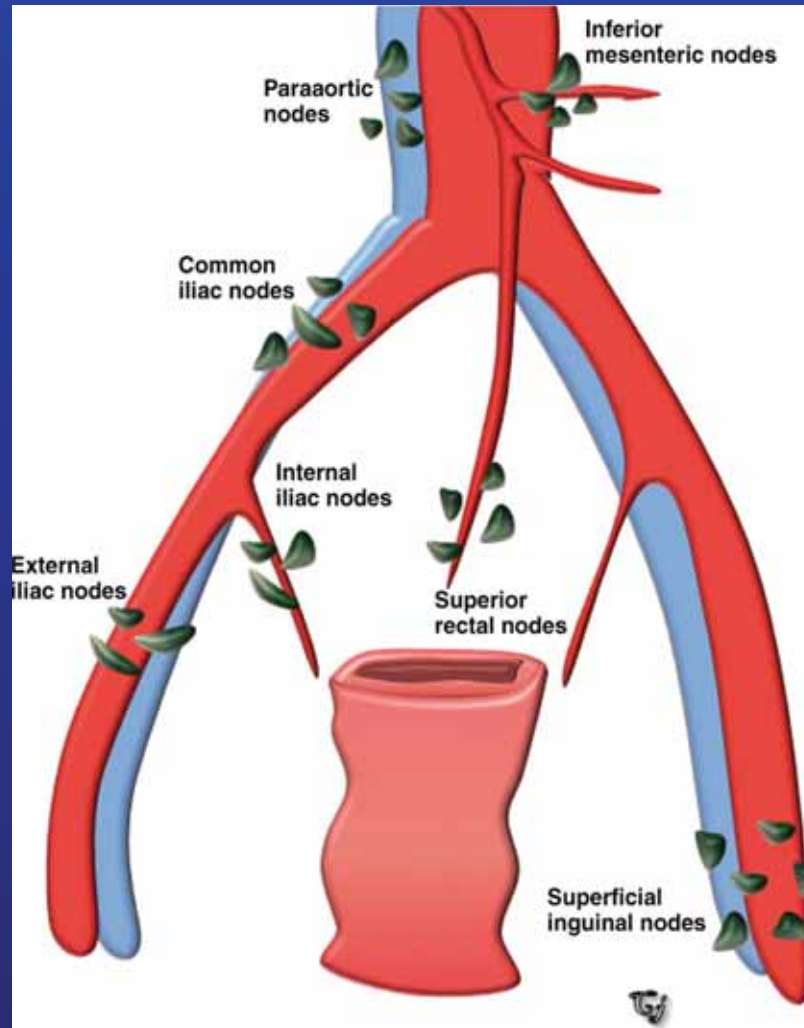
Upper Rectum

epicolic nodes → pararectal nodes → intermediate
mesocolic nodes → principle IMA nodes

Lower Rectum

middle and inferior rectal vessels → hypogastric and
obturator nodes → paraaortic nodes

common nodal pathways of tumor spread

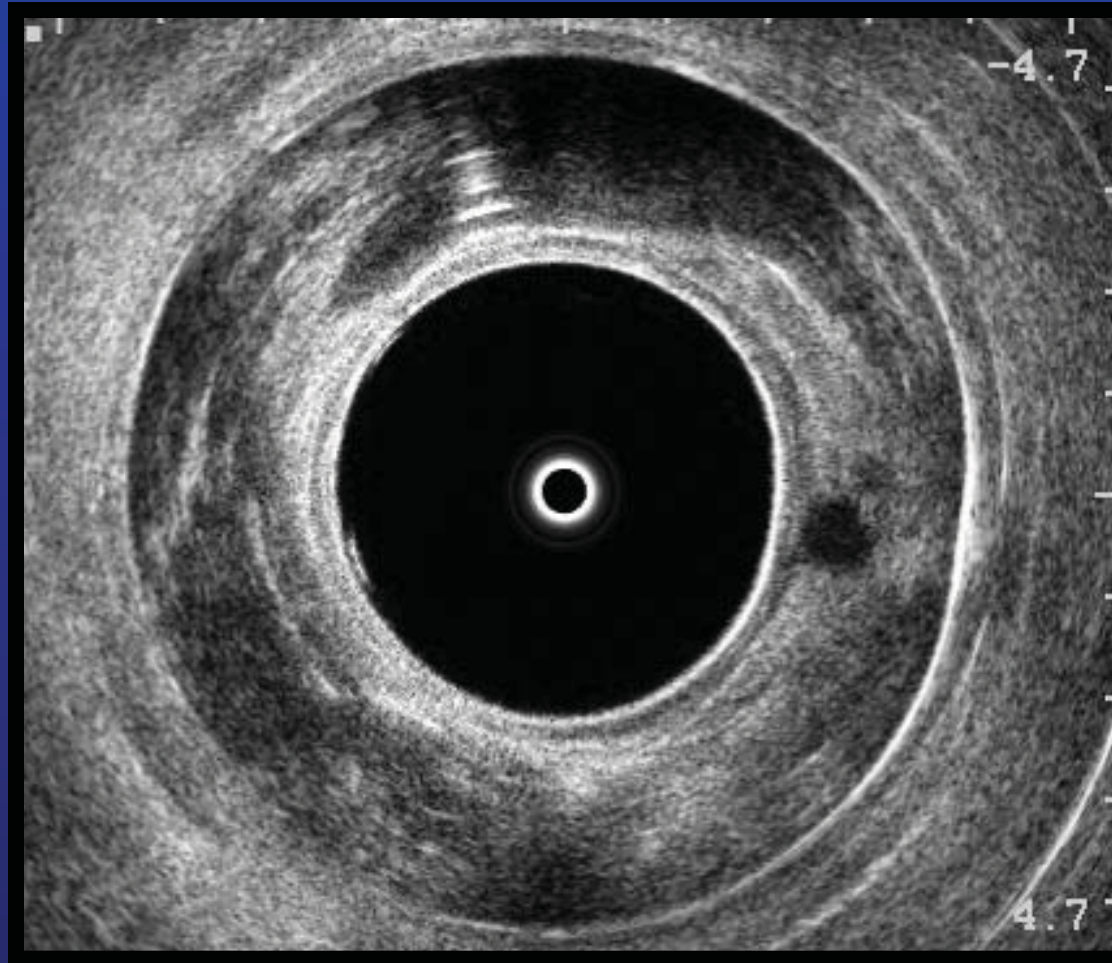


Kaur H et al. Radiographics 2012;32:389-409

RadioGraphics

Nodal Criteria for Size?

N = Regional Lymph Nodes



Nodal Criteria for Size

• Retroperitoneal	10 mm
• Mesenteric	10 mm
• Common Iliac	9 mm
• External Iliac	10 mm
• Internal Iliac	7 mm
• Obturator	8 mm
• Superior Rectal	5 mm
• Pararectal	3 mm
• Deep/Superficial Inguinal	10 mm
• Lateral Sacral	7 mm

Nodal spread and micrometastasis within mesorectum

- 31 consecutive patients
- No chemo/radiation
- 21 T3
- 992 lymph nodes harvested
- metastasis found in 148 nodes

Nodal spread and micrometastasis within mesorectum

<1mm	7%
<2mm	24%
<5mm	70%

Nodes

Size criteria

Tradeoff

Size

Sens

Spec

3mm

78

59

10mm

3%

100%

Brown G. Br J Surg. 2003;90

N=188

EUS/MR staged T3 N0

- Multicenter
- 188 pts
- T3 N0 ERUS/MRI
- preop Ch-RT

N=188

EUS/MR staged T3 N0

- 22% of patients undetected mesorectal LN involvement despite Ch-RT

Nodal spread

Overall accuracy 60-80%

No differences ERUS/MR/CT

T stage correlates with LN positivity

T stage correlates with accuracy LN staging

Wang C et al. World J Gastroenterol 2005 June 21

Other criteria

Amount not helpful

sens

spec

Spiculated

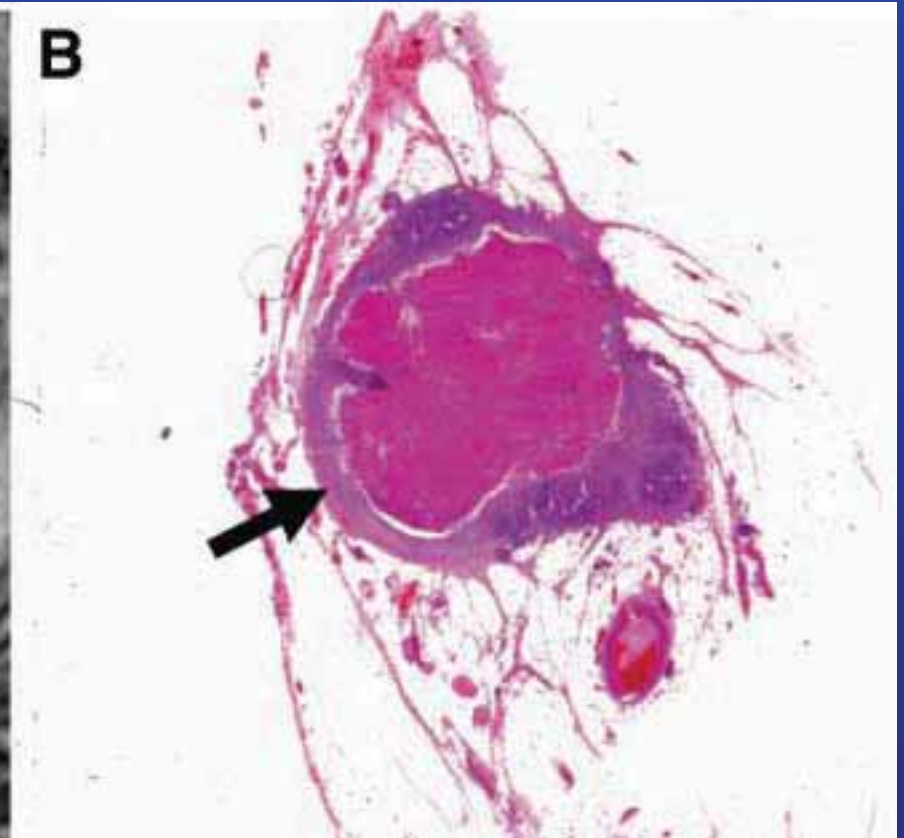
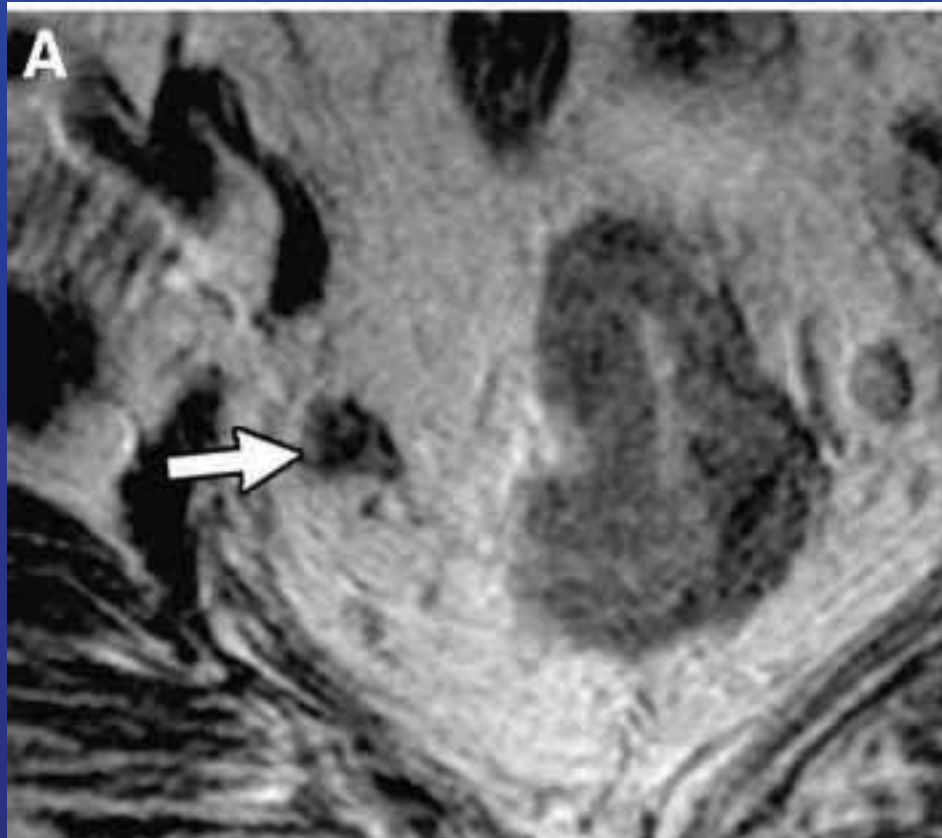
Indistinct

Heterogeneous

85%

98%

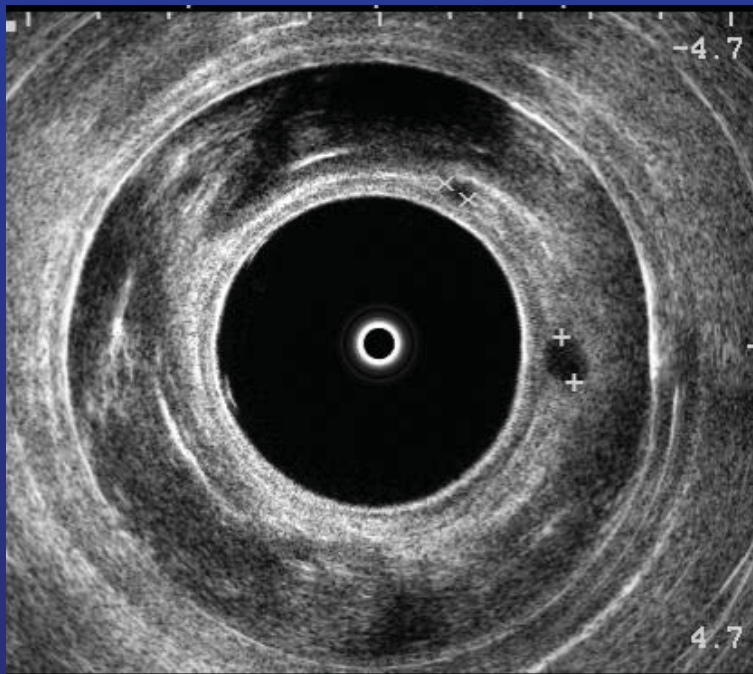
Kim JH. Eur J Radiol. 2004 Oct;52(1):78-83.



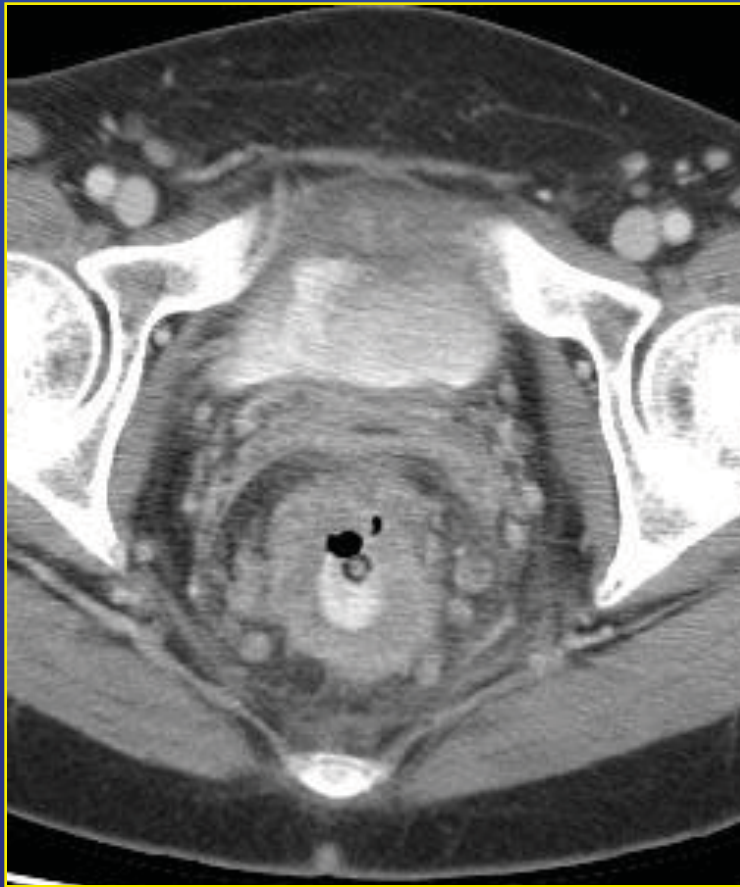
Irregular Border and Mixed Signal Intensity

Cancer Care Ontario

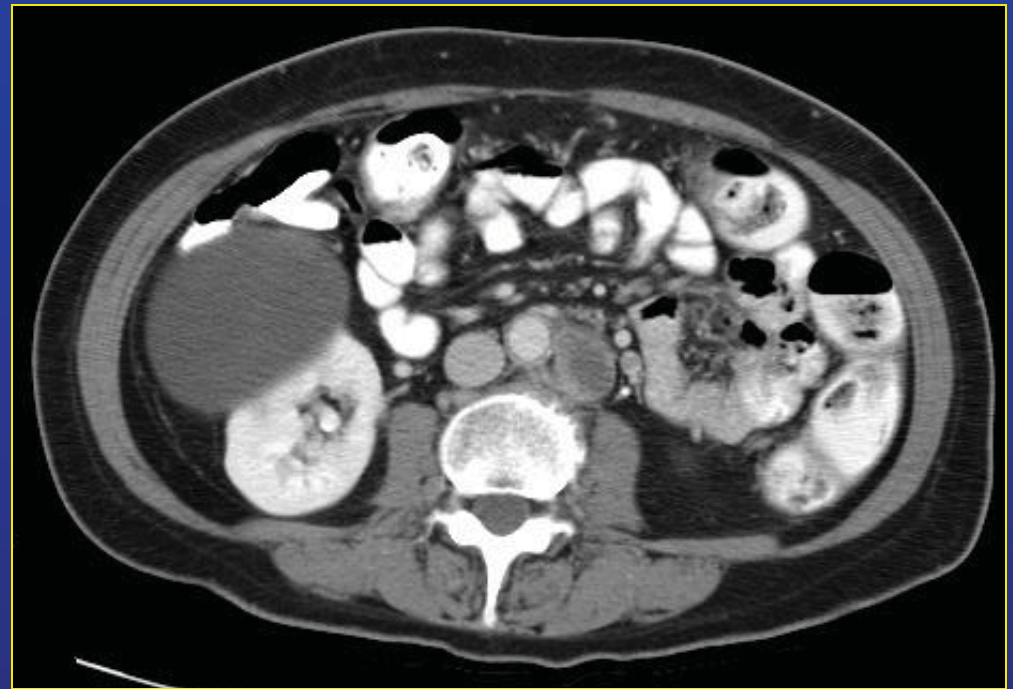
Reliability of imaging modalities for predicting lymph node involvement uncertain



Up to 20% of patients have involved nodes of less than 3mm



Enlarged pararectal nodes



Enlarged left paraaortic node

N + = 100% positive

Conclusion

T stage assessment is fairly accurate

**N stage is only moderately effective
whatever modality is used**

Conclusion

- **New techniques**
 - DWI
 - Specific contrast agents
 - USPIO, Gadofosveset
 - PET/CT PET/MR ??

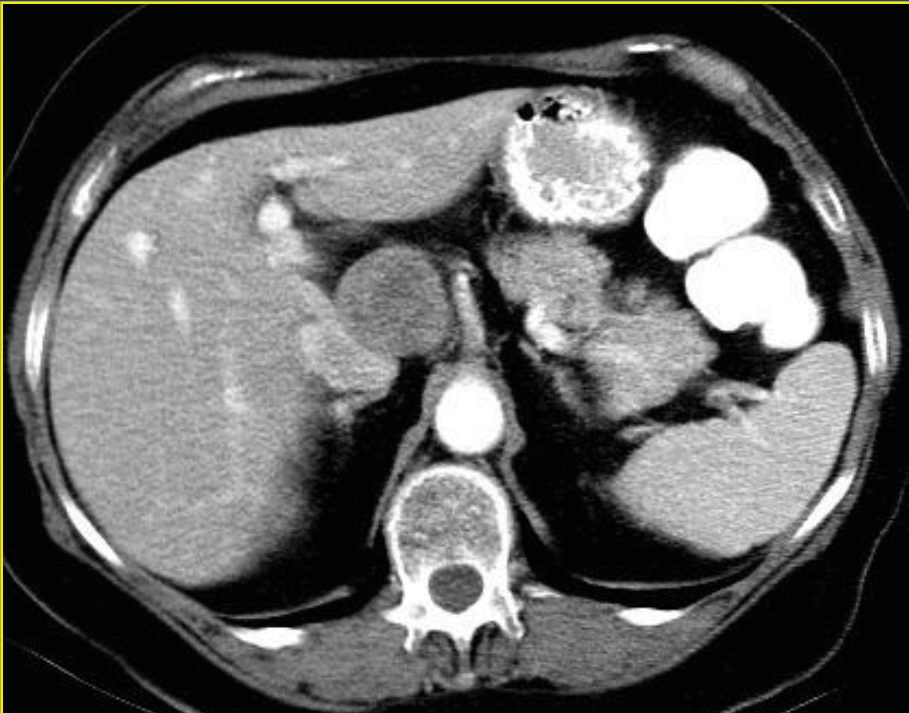
M = Distant Metastases

MX = Distant metastases cannot be assessed

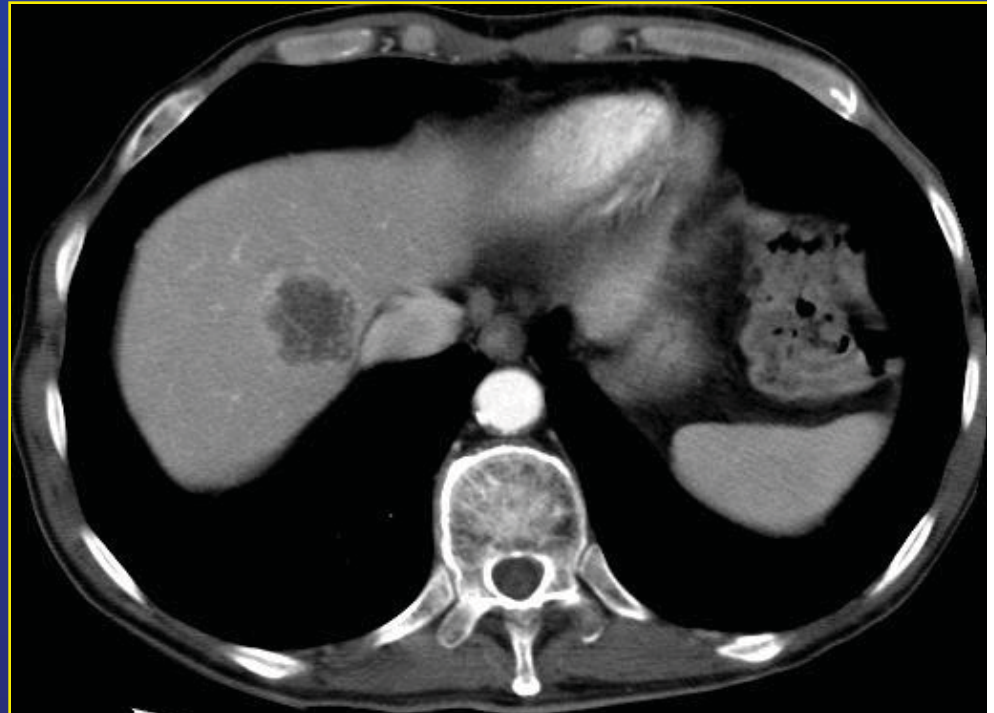
M0 = No distant metastases

M1 = Distant metastases

Distant Metastases



Enlarged portocaval node



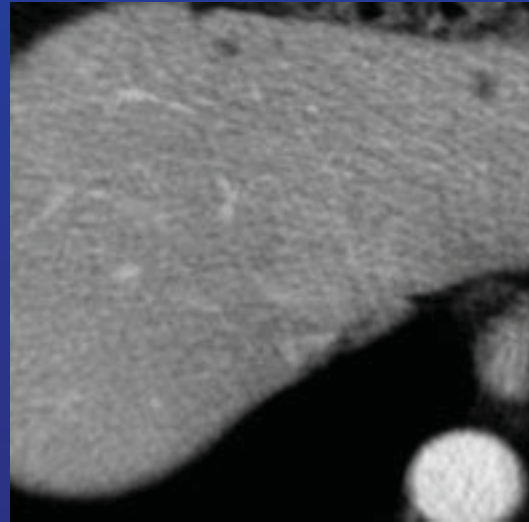
Liver metastasis

Distant disease and Follow-up

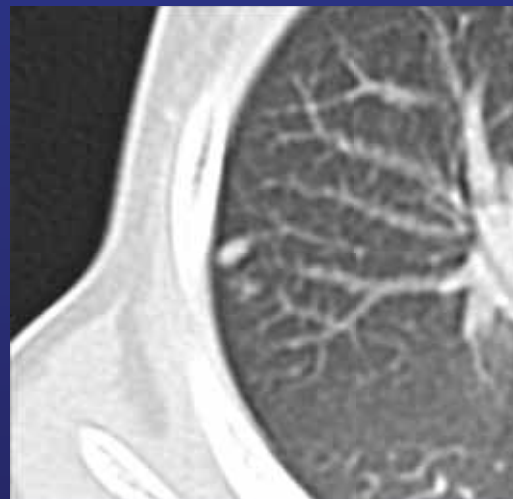
- Generally CT sufficient
- Follow-up: How often? How long?
- What to do with incidental findings?
 - Liver: subcentimeter lesions TSTC
 - Lung: small nodules ILN

What to do with incidental findings?

– Liver: TSTC



– Lung: ILN



Prevalence and importance of small hepatic lesions found at CT in patients with cancer

- CT 2,978 patients with cancer
- Benign: 303/2978 (80.2%) patients
- Malignant 44 (11.6%) patients
- Indeterminate 31 (8.2%) (short FU)
- CRC: mets in 14% pts with CRC

Schwartz LH. Radiology. 1999 Jan;210(1):71-4.

Prevalence and importance of small hepatic lesions found at CT in patients with cancer

- CONCLUSION:
- small hepatic lesions in patients with cancer majority is benign
- metastases in 14 % of patient

Schwartz LH. Radiology. 1999 Jan;210(1):71-4.

Natural history of small, "indeterminate" hepatic lesions in patients with colorectal cancer

- 70/419 patients (16.7%) small liver lesions TSTC
- 46 patients (65.7%) subsequent imaging of their liver lesions
- 41 (89.1%) stable likely benign
- 5 (10.9%) progression suggestive of mets

Lim GH. Dis Colon Rectum. 2009 Aug;52(8)

CT follow-up hypoattenuating small liver lesions in patients with rectal ca

- 616 consecutive patients
- 70 patients with 163 hepatic lesions
- Patients stable 80%
- Lesions Stable 90.8%
- No significant difference in results was found for patients stratified according to T-stage

Tan CH. Am J Clin Oncol. 2011 Aug;34(4)

CT follow-up hypoattenuating small liver lesions in patients with rectal ca

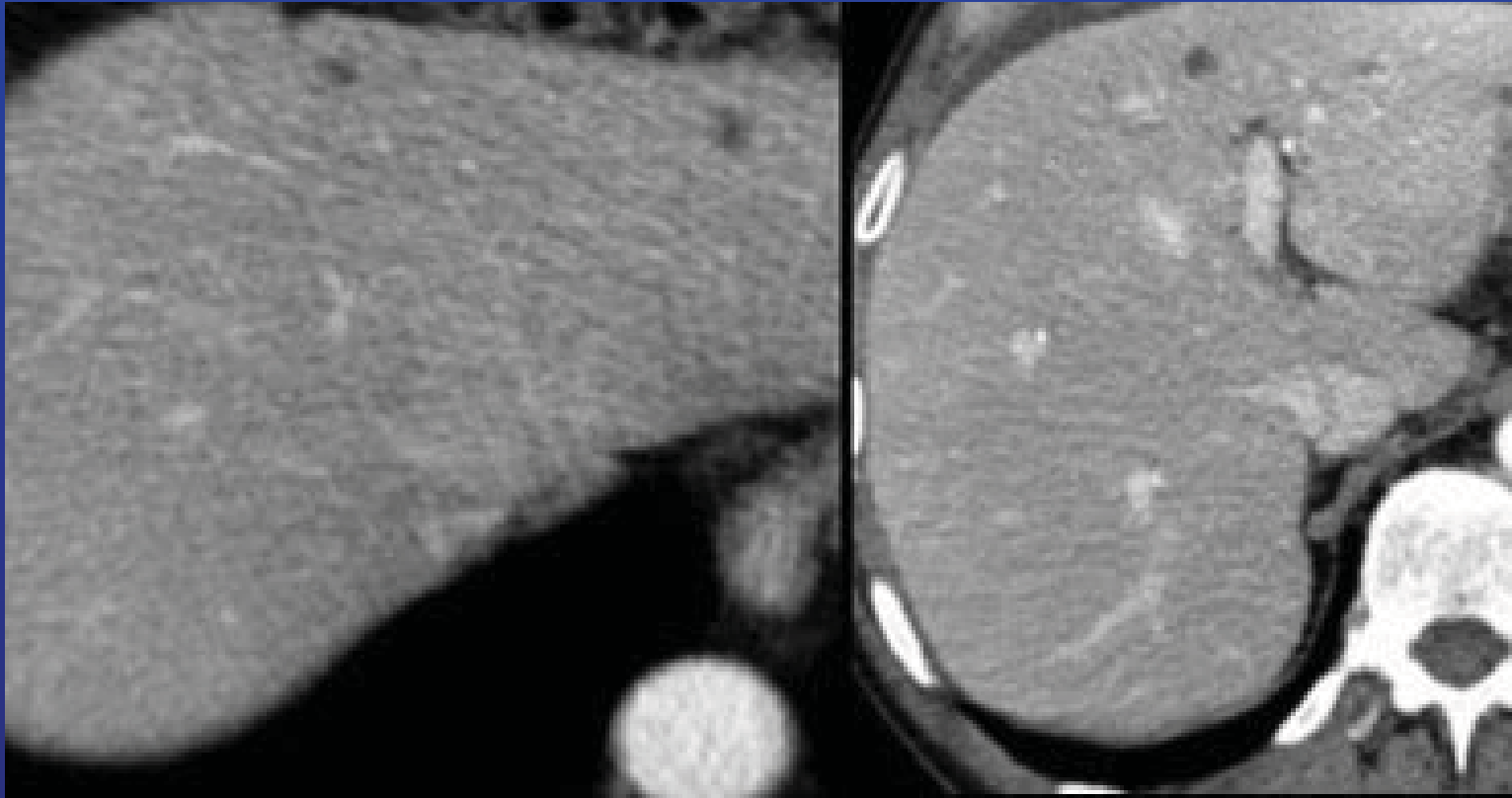
- CONCLUSION
- majority of small hypoattenuating liver lesions remain stable and treated as benign lesions
- Closely followed for at least 1 year after completion of therapy

Tan CH. Am J Clin Oncol. 2011 Aug;34(4)

CECT

- retrospective study breast ca
- 1012 woman CT
- 277 pts TSTC but no definite liver metastases at initial CT
- 92.7%-96.9% the lesions represented a benign finding

Hanan I et al. Radiology. 2005, 235(3):



TSTC

Problem solving

- US: small cysts
- MRI: hepatocyte-specific contrast agents
Gd-EOB-DTPA (Primovist)
- Follow-up

colorectal cancer metastasis

	CECT	MRI	PET	PET-CT
Sens per lesion	69-79%	75-85%	67-91%	55-75%
Spec per patient	93-96%	90-95%	93-98%	93-99%

Frankel et al. J Gastrointest Oncol. 2012
Niekel et al. Radiology. 2010 Dec

Lung Nodules

ILN



Screening studies, up to 51% of smokers aged 50 years or older have pulmonary nodules on CT scans

CT staging of colorectal cancer: what do you find in the chest?

- 568 CRC complete CT staging
- 31 (6%) had lung metastases
- 353 (68.7%) no evidence of metastases
- 130 (25.3%) had indeterminate lung nodules
 - 12 patients subsequently confirmed as mets
- 3% major non-metastatic finding (PE, Lung Ca)

McQueen, Clin Radiol. 2012 Apr;67(4)

CT staging of colorectal cancer: what do you find in the chest?

CONCLUSIONS:

- 1. Thoracic CT altered initial TNM stage in fewer than 1% of CRC patients**
- 2. detection of significant incidental chest disease and the establishment of an imaging baseline are useful outcomes of this imaging strategy**
- 3. staging examinations 25% ILNs**

McQueen, Clin Radiol. 2012 Apr;67(4)

Pulmonary staging in colorectal cancer: a review

- A review of studies assessing chest staging modalities for patients with CRC
- Majority were case series
- Low pick-up rate for CXR
- Increased detection rates chest CT

Pulmonary staging in colorectal cancer: a review

Rectal ca: incidence lung mets 10%-18%

Colon cancer: incidence lung mets 5-6%

Clinical benefit of increased detection rates not clear

Incidence ILN 4%-42%

Majority ($\geq 70\%$) of ILN's did not have any clinical significance

Parnaby CN. Colorectal Dis. 2012 Jun;14(6):660-70

Pulmonary staging in colorectal cancer: a review

Incidence of synchronous liver and pulmonary metastases 45% to 70%

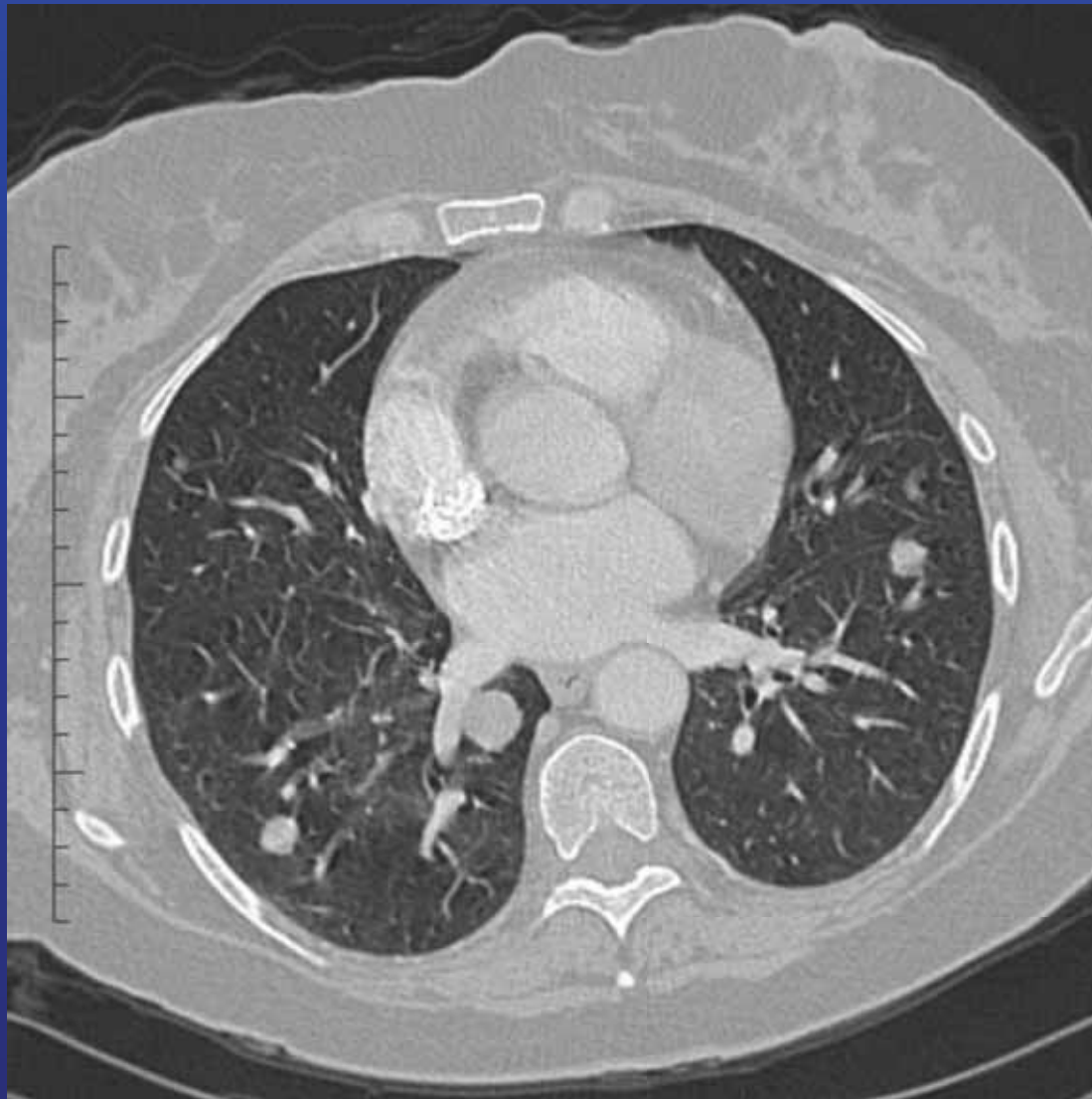
No evidence superiority of PET/CT vs CT for the detection of pulmonary metastases or characterization of ILL

Parnaby CN. Colorectal Dis. 2012 Jun;14(6):660-70

Pulmonary staging in colorectal cancer: a review

- **CONCLUSION:**
- **CT scanning increases the detection rates for ILL and pulmonary metastases**
- **Clinical benefit increased detection rates not clear**
- **Paucity of data optimal chest staging strategy**

Parnaby CN. Colorectal Dis. 2012 Jun;14(6):660-70



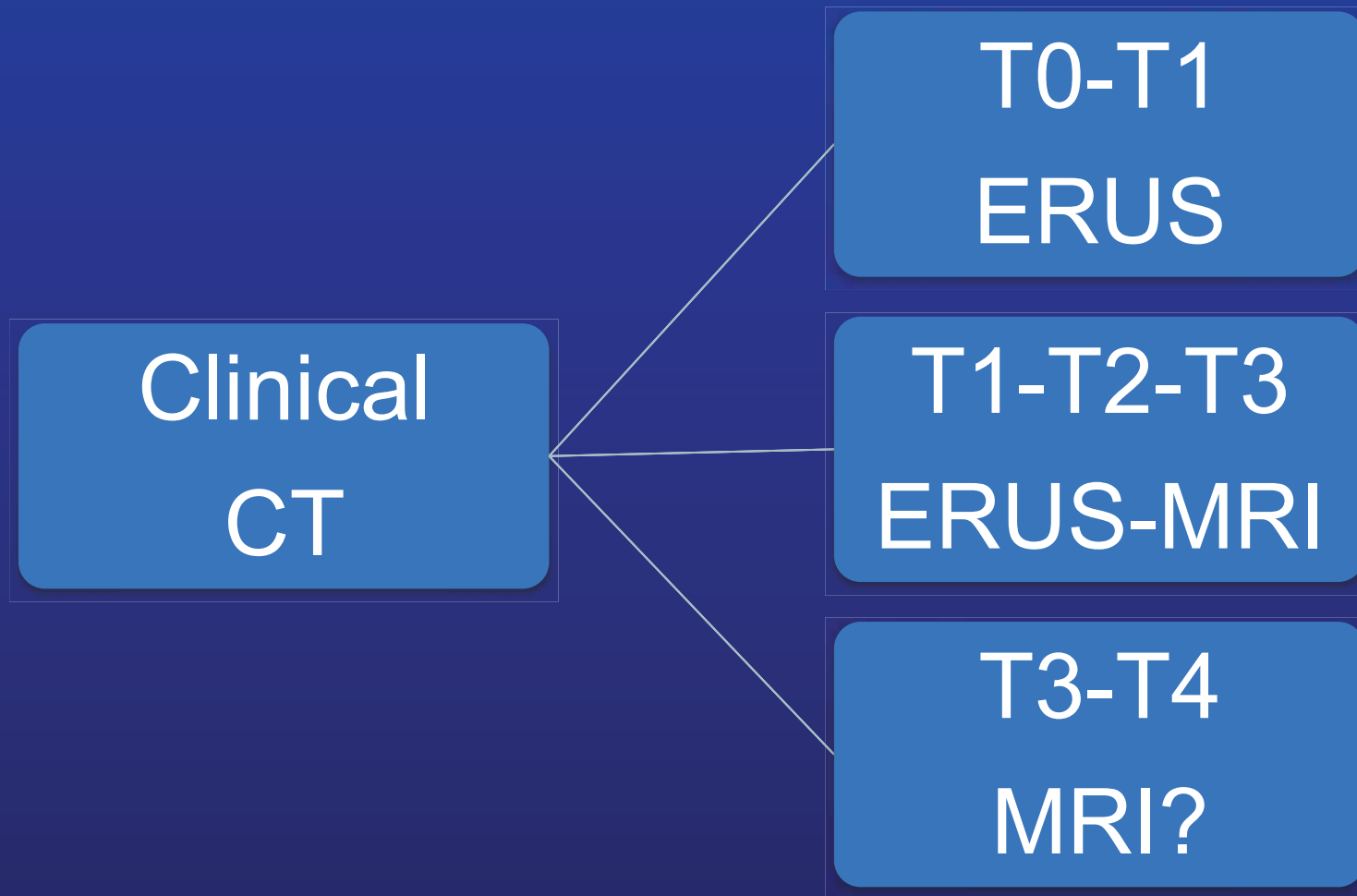
Mets Colon ca

Summary

Summary

- Best choice Imaging depends on T stage

Suggestions: Imaging Strategy



Summary

- Imaging often complimentary
- Overstaging: ERUS + MRI
- Accuracy LN 60-80%

Summary

- **Have a plan:**
 - Liver: TSTC
 - Lung: ILN's
- **Clinical benefit of increased detection rates not clear**

Summary

- **Standardized/Template reporting?**

APPENDIX A: MRI SYNOPSIS REPORT

This document was developed by Drs Elsar Al-Sukhni, Laurent Milot, Mark Fruchtman, Gina Brown, Selina Schmockler and Erin Kennedy for the Cancer Services Innovation Partnership – a joint initiative of Cancer Care Ontario and the Canadian Cancer Society

1. MRI PROTOCOL

Overall image quality: ☐ Adequate ☐ Suboptimal ☐ Non-diagnostic

2. TUMOUR LOCATION

Tumour location (from anal verge): ☐ Low (0-5.0 cm)
☐ Mid (5.1-10.0 cm)
☐ High (10.1-15.0 cm)

Distance of the lowest extent of tumour from anal verge: _____ cm

Distance of lowest extent of tumour from top of the anal sphincter: _____ cm

Relationship to anterior peritoneal reflection: ☐ Above ☐ At or straddles ☐ Below ☐ Not able to assess

3. TUMOUR CHARACTERISTICS

Circumferential extent/location (clock face): _____

Craniocaudal extent: _____ cm

Mucinous: ☐ No ☐ Yes

4. T-CATEGORY

i) T-category:

- ☐ T1 or T2
☐ T2/early T3 (includes spiculation of the perirectal fat)
☐ T3
☐ T3/possible T4*
☐ T4*

*Please indicate structures with possible invasion: _____ (see list below)

GU	PELVIC SIDE WALL	BONE/VASCULAR	OTHER
bladder	Obturator internus	sacrum (specify level)	Anterior peritoneal reflection
left ureter; right ureter	Piriformis	left internal iliac vessels; right internal iliac vessels	
prostate		left external iliac vessels; right external iliac vessels	
uterus	LEVATOR ANI		
vagina	Pubococcygeus		
	Ileococcygeus		
	Coccygeus		

ii. For low rectal tumours (0 - 5 cm) only:

Is the lower extent of the tumour at or below the top border of the puborectalis? ☐ No ☐ Yes*

*If yes, please complete the following section for the most penetrating component of the tumour below the top border of puborectalis:

- ☐ Possible confinement to the submucosa; no definite involvement of internal sphincter (suspected T1)
☐ Confined to the internal sphincter; no involvement of intersphincteric fat or external sphincter (early T2)
☐ Through the internal sphincter and intersphincteric fat; possible or definite involvement of the external sphincter (advanced T2)
☐ Through the external sphincter and into surrounding soft tissue; no organ involvement (T3)
☐ Through external sphincter and possible involvement of the adjacent organs (i.e., prostate, vagina) (T3/T4)
☐ Through external sphincter and definite involvement of adjacent organs (i.e., prostate, vagina) (T4)

5. DISTANCE TO THE MRF AND EXTRAMURAL DEPTH OF INVASION (EMD)

i) Shortest distance of the definitive tumour border to the MRF = _____ mm
[or ☐ unable to estimate or ☐ not applicable (involving the peritonealized portion of the rectum or T4a)]

ii) Extramural depth of invasion (EMD) at this level = _____ mm
[Record 0 mm for T1 and T2 tumours]

iii) Are there any tumour spiculations closer to the MRF? ☐ No ☐ Yes*

*If yes, please specify distance = _____ mm and location _____ (on clock face)

iv) Is there any other component of the tumour (any T1-3) closer to the MRF? ☐ No ☐ Yes*

*If yes, please specify distance = _____ mm and location _____ (on clock face)

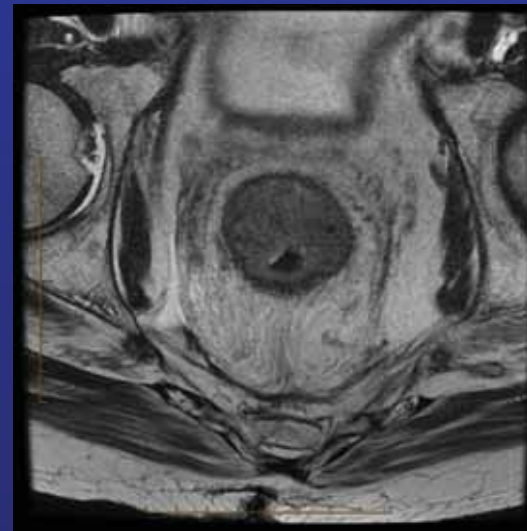
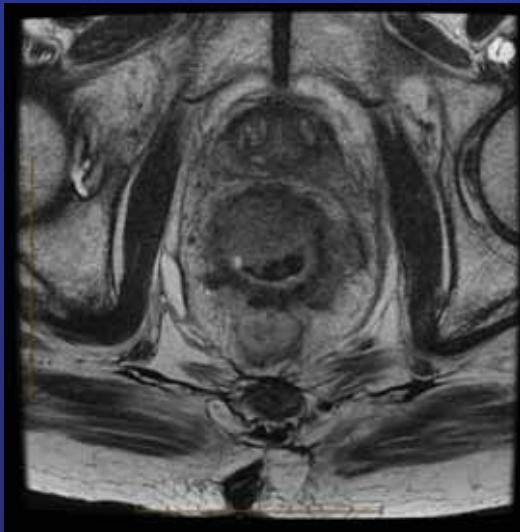
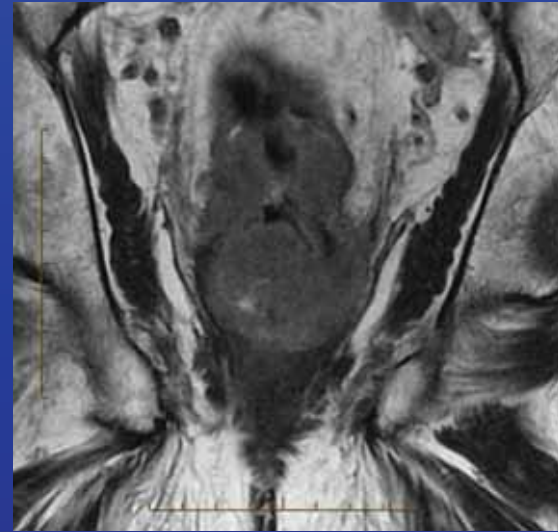
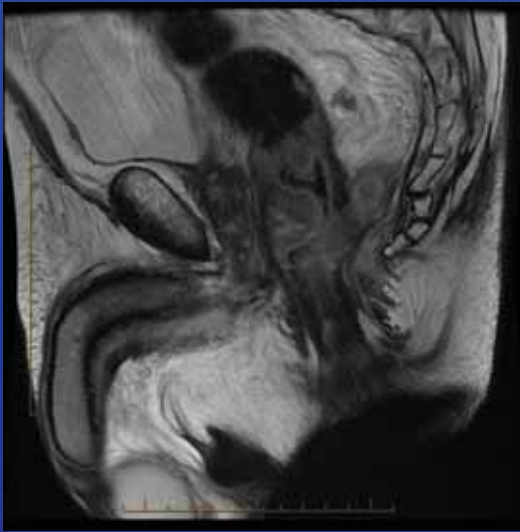
6. EXTRAMURAL VASCULAR INVASION (EMVI)

EMVI: ☐ Absent ☐ Equivocal ☐ Present

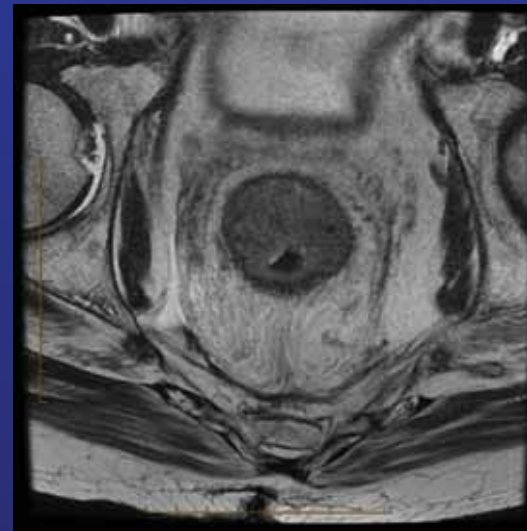
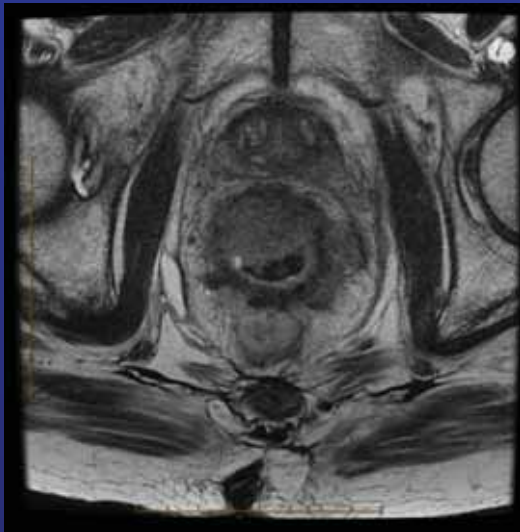
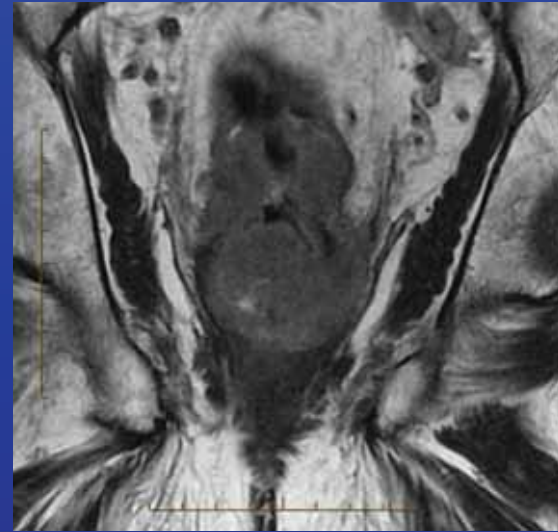
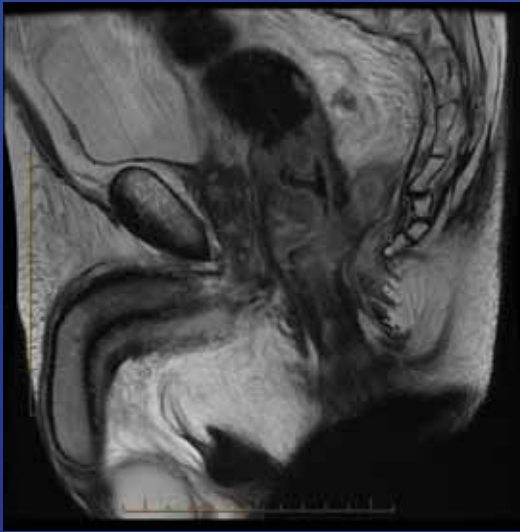
7. MESORECTAL LYMPH NODES AND TUMOUR DEPOSITS

Any suspicious mesorectal lymph nodes and/or tumour deposits? ☐ No ☐ Yes*
(suspicious = irregular border, mixed signal intensity and/or ≥ 8 mm)

*If yes: (please complete a and b)



Stage?



T3 CRM+

∞ The end ∞